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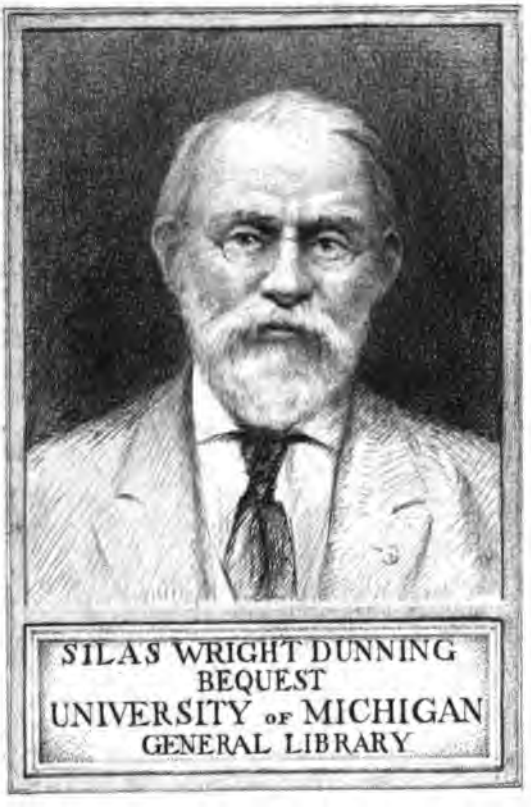

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MDCCCCI.

MONOGRAPH

OF THE

COCCIDÆ OF THE BRITISH ISLES.

BY

ROBERT NEWSTEAD,

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VOLUME I.

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THIS VOLUME IS,

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AS A TOKEN OF GRATITUDE AND SINCERE RESPECT,

BY THEIR OBLIGED AND FAITHFUL SERVANT

THE AUTHOR.

PREFACE.

CONSIDERING the destructive nature of many Coccids found in the British Isles, it is remarkable to find that in the past, comparatively little attention has been paid to this important group of insects by the entomologists of this country. Prior to 1881, Curtis and Westwood were the only two authorities who contributed anything of importance concerning these insects, but they described very few species, and altogether the work of the earlier writers is of a desultory and intermittent character.

In the 'Entomologist's Monthly Magazine,' at the beginning of the year 1881, the veteran entomologist Mr. J. W. Douglas began a series of articles on British and Exotic Coccidæ, which he continued to publish for several years, until sickness, unfortunately, compelled him to retire. In his first paper* the author gives an account of the species of the genus *Orthezia*, which was followed later† by a further contribution to the same genus, accompanied by a plate of beautiful illustrations of the three indigenous species. In vol. xxii of the first-named magazine he gives a list of twenty-two species found in Britain, and enumerates five others from Stephens' Catalogue of British Insects. Of these, fourteen species are referred to the genus *Lecanium*, but several of these have proved to be

* Entomologist's Monthly Magazine, vol. xvii, pp. 171—176.

† Trans. Entomological Soc. Lond., 1884. Part I, pp. 81—86, pl. ii, figs. 1—7.

synonyms of earlier species, and will have to sink. Subsequently, the same author dealt with about fifty species of British Coccidæ, including several new species, and the following new genera:—*Ischnaspis*, *Gymnococcus*, and *Cryptococcus*.

As a practical gardener, I had for many years been fully acquainted with the destructive habits of the "mealy bugs" and "scale insects" of our fruits and cultivated flowers; but it was not until the year 1889 (three years after my present appointment) that I began in earnest the study of the group on more scientific lines, when, acting under the advice of my late employer and friend, Mr. Alfred Osten Walker, F.L.S., I began a systematic study of the group. My first reward was the discovery of the apterous and winged males of *Chionaspis salicis*, Linn., which discovery ultimately led to a lasting correspondence with that able and accomplished entomologist, Mr. J. W. Douglas, to whom I owe many debts of gratitude for hints ungrudgingly given, and for the liberal supply of all his types, which, needless to add, has very materially aided me in the preparation of this monograph.

All my contributions to the study of the Coccidæ of this country are given in the pages of the 'Entomologist's Monthly Magazine' (1891 to 1901), which contains descriptions of about twenty new and undescribed species, besides other interesting additions to the British Fauna.

At the present time about ninety species and varieties of Coccids are known to occur in the British Isles; of which this volume deals only with the sub-family Diaspinæ. Of this comparatively small total those found in our greenhouses and conservatories are undoubtedly of foreign origin; many of the indigenous species are almost cosmopolitan; while a few, and especially the subterranean species, may prove peculiar to the British Isles.

It may be safely said that no work on the Coccidæ

of any country could be considered a complete and useful work of reference without the inclusion of the introduced species. This particularly applies to the British Isles, where the majority of the Coccidæ are injurious to plants and fruits cultivated under glass. Taking this important fact into consideration, it has been thought advisable to make this monograph representative of all the species found *living* in this country, so that the work may not only appeal to the naturalist, but to all those who are interested in horticultural pursuits. With this object in view instructions are given on the methods of prevention and remedies, to which have been added, from foreign sources, the most approved modern systems of combating these insects on a larger scale than is usually employed in this country. Besides this, the horticulturist will also find valuable data on the natural enemies of the Coccidæ. For the first time, proof is afforded from post-mortem examinations of the nature and extent to which certain birds have been found to feed upon our indigenous Coccids (see pages 33—41).

The drawings on the plates have, as far as possible, been made to a uniform scale throughout, and the *approximate* magnification has been given. Each species is also shown of the natural size, *in situ*, on a portion of the food-plant, which may further assist the horticulturist in the identity of the insect. But it should always be remembered that the correct determination of a species lies almost invariably in the careful preparation and microscopical examination of the specimens.

In preparing the descriptions of the insects a vast amount of material from foreign sources has been examined for comparison with the examples found in this country.

As far as it has been possible to do so the descriptions and illustrations have been made from British specimens, but where the material has been scanty or imperfect the diagnosis has been completed from

exotic specimens. Fortunately it has been found necessary to do this in two or three instances only, where full acknowledgment has been made.

The terms used in this work are chiefly those employed by other students of the group, of which a full glossary will be given in the second volume.

The greater number of localities in this monograph have been made by myself; when otherwise, the name of the collector has been added in brackets.

The Bibliography of the Coccidæ will appear in the second volume. But I wish here to draw special attention to some of the principal authorities and their publications. Signoret's Essai sur les Cochenilles is a valuable though costly monograph, embracing all the known species of Coccidæ to the completion of its publication in 1876. The works of our late lamented friend and colleague, Mr. W. M. Maskell, are a monument to his untiring energy in the researches of the Australasian Coccidæ; they are, needless to say, of the utmost importance to the student. Dr. W. W. Froggatt's papers on the gall-making Brachycelinæ of Australia are also of great interest and value, embracing as they do descriptions of the most remarkable sub-family of the Coccidæ.

In the United States the Reports of Professor Comstock are of much help, and beautifully illustrated; this may also be truly said of the Departmental publications by the late Dr. C. V. Riley and the present States Entomologist, Dr. L. O. Howard. In the same country Professor T. D. A. Cockerell's writings are of a very extensive character, embracing a number of valuable and important contributions. And quite recently Mr. R. A. Cooley has commenced and partly published a very important paper on the genus *Chionaspis*, which is also profusely illustrated. Mr. E. E. Green's 'Coccidæ of Ceylon,' when completed, will form one of the most valuable of modern works on the group; moreover it is beautifully and accurately illustrated by his own masterly hand. Dr. Berlese, of

Portici, Italy, has made most extensive contributions to our knowledge of the physiology and morphology of the Coccidæ, and I may also specially mention his excellent monograph of the genus *Aspidiotus*.

To the Royal Society, through Prof. E. B. Poulton, F.R.S., I owe my heartiest thanks for their liberal support in granting to me a sum of £20, which has enabled me to explore many unworked localities, thereby contributing in no small way to our knowledge of the distribution of the indigenous species of the British Coccidæ, and the discovery of material of great scientific value; while to the Ray Society I am most of all indebted for their unbounded generosity in publishing the researches of my labours.

My thanks are also tendered to Dr. L. O. Howard, United States Entomologist, for so kindly naming the various Hymenopterous parasites of the Coccidæ which are enumerated in the text.

To Mr. E. E. Green, Government Entomologist, Ceylon, I am specially indebted for examples of his types of British species, and also for a vast amount of exotic material and papers. In England also to Mr. G. Nicholson, Curator of the Royal Botanic Gardens, Kew; to Messrs. T. R. Hodges, A. J. Nixon, A. T. Gillanders, Brockton Tomlin, Miss Tomlin, and Miss C. E. Tomlin, for their unfailing interest in collecting material.

To Dr. Karel Sulc in Bohemia for European species and much valuable information concerning Signoret's types; to Dr. Gustavo Leonardi and Prof. Antonio Berlese, Portici, Italy; to Profs. T. D. A. Cockerell, J. H. Comstock, R. and C. H. Fernald in America; to Dr. Morris, Commissioner of the Board of Agriculture for the West Indies; to Dr. W. W. Froggatt, Official Entomologist of Sydney, New South Wales; to Mr. C. F. French, Official Entomologist of Victoria, Australia; to the Rev. A. E. Eaton in North Africa; and Mr. C. P. Lounsbury, Government Entomologist, Cape Colony, I tender my warmest thanks for much valuable material, types, and important papers on Coccidæ.

I must also specially thank Mr. Alfred Osten Walker for his able guidance in many matters relating to this work, and the Rev. Dr. Thos. Wiltshire, F.L.S., the Secretary of the Ray Society, for undertaking the laborious task of reading through my proofs and offering valuable suggestions.

With two exceptions all the illustrations have been drawn by myself expressly for this work; and the reproductions by lithographic process have been prepared with great care and fidelity by P. W. M. Trap, of Leiden. Dr. Maxwell T. Masters, the Editor of the 'Gardener's Chronicle,' has kindly permitted the use of the blocks illustrating *Aulacaspis pentagona* (Figs. 19, 20, p. 174); and the Rev. W. Wilks, M.A., Secretary of the Royal Horticultural Society, the ten blocks illustrating Plates A to E. Plate XI, fig. 7, showing the marginal fringe of the pygidium of *Aspidiotus perseæ*, is copied from Prof. Comstock's drawing (Report 1880, pl. xii, fig. 3). The comparatively recent discovery of five species of Diaspinæ has necessitated the illustrations of them accompanying the text; otherwise, they would have appeared in order upon the lithographic plates; but it was fully intended the diagrams illustrating the various parts of the Diaspinæ should accompany the letterpress concerning them. It was thought by so placing them the student would be saved the necessity of cross-reference to plates.

R. N.

Grosvenor Museum,
Chester;
October 1*st*, 1901.

INTRODUCTION.

Life-history and Metamorphoses.

In dealing with the life-history and metamorphoses of the Coccidæ as set forth in the introductory chapters which follow, I have endeavoured to lay before the student a few facts concerning the more salient characteristics of this remarkable group of insects, in which order of form and diversity of habit are not excelled by any other section of the Homoptera. Fuller accounts of the habits of individual species accompany the descriptions of the various genera and species.

The food-plants of the indigenous Coccids are chiefly deciduous trees and shrubs. Some species are exclusively confined to one food-plant; while others, less discriminative, feed upon several. Thus, for example, *Aspidiotus zonatus*, Frauen., **Asterodiaspis quercicola*, Bouché, *Lecanium ciliatum* (Newst. MS.), Douglas, feed exclusively upon the oak (*Quercus robur*); *Cryptococcus fagi*, Barens, upon the beech (*Fagus sylvatica*); *Physokermes abietis*, Mod., upon the spruce fir (*Abies excelsa*); *Diaspis carueli*, Targ., upon the juniper (*Juniperus*, sp.); and *Apterococcus fraxini*, Newst., upon the ash (*Fraxinus excelsior*); while *Mytilaspis pomorum*, Bouché, and *Chionaspis salicis*, Linn., are found upon plants belonging to widely separated orders.

* Mr. Cockerell considers this a synonym of *Asterolecanium variolosum*, Ratz.

Again, certain plants are much more productive than others: thus the oak and the hawthorn (*Cratægus oxyacantha*) each supports five species; the ash, willow (*Salix*, spp.), and rose (*Rosa*, spp.) two. Indigenous ferns are quite immune, which is remarkable, and all the more so as many cultivated species are subject to, and not a few are difficult to cultivate owing to, the ravages of these pests.

Many Coccids found under glass confine their attacks to one or two species of plants, or a single group of plants; and others, such as the "mealy bugs" (*Dactylopius*, spp.) are very general feeders, but give preference to *Stephanotis*, *Euphorbia*, *Lantana*, *Abutilon*, various palms, crotons, cucumbers, melons, vines, etc.

The favourite localities for indigenous species are at the margins or openings in woods, also trees in hedgerows and in parks and fields; while a mixed hedgerow of hawthorn, sloe, bramble, wild roses, and coarse grasses, having a sunny aspect, affords the best shelter for several species. Certain species, however, occur in the most exposed situations, and seem to endure cold and wet with equanimity. Thus *Ripersia subterranea*, Newst., and *Lecanopsis formicarum*, Newst., live on the roots of grasses in ants' nests on the sea-shore just above high water mark. I have also found *Orthezia urticæ*, Linn., in abundance on the salt marshes at Heacham, Norfolk—a most remarkable habitat, as in winter parts of the locality would be occasionally inundated. It was in the month of August when first I discovered this interesting colony of *Orthezia*; they were then swarming over the low plants, and in some instances the young insects completely covered the tender shoots of *Glaux maritima*. We meet with the same insect upon heather-clad moors far removed from the sea, which latter habitat *O. cataphracta*, Shaw, also shares; while *O. floccosa*, De G., loves a heather-clad spot in the open wood, or a grass-covered sunny bank.

Coccids are lovers of the sunshine, and seem to thrive and multiply best in warm sheltered situations

—a fact most noticeable in *Mytilaspis pomorum* and *Lecanium persicæ*, Fabr. If we take the former we find, although it occurs most freely upon standard trees, it rarely infests them to such an extent as to cause serious injury, its attacks being chiefly confined to the trunk and main branches; whereas, if it once establish itself upon a tree trained against a south wall, the insects in time will cover every branch and twig, and finally will attack the fruit and leaves also. The effect of still more favourable conditions is even better illustrated by *Lecanium persicæ*. This insect is usually found wherever the peach and nectarine are cultivated, but outdoors I have never found it in sufficient numbers to cause injury to the trees; under glass, however, it increases at such an enormous rate that it becomes a matter of great importance to keep the insect in check.

In spite of the apparent increase of individuals under favourable conditions, the vitality of certain tender exotic species, when exposed to frost, is most remarkable. I have known various stages of *Diaspis bromeliæ*, Ker., to endure frost for several days, and have subsequently reared a number of the males by placing them in a temperature of about 70° F. I have also known "mealy bugs" to survive the winter outdoors on the ivy-clad wall of a hothouse, which no doubt afforded them material warmth and shelter, but could not have shielded them from the severe frosts to which they were exposed. Under such conditions they did not increase in numbers, and I have little doubt that in time they all succumbed to the exposure.

Like plants and trees, our indigenous Coccids rest throughout the winter, some in the egg, others in the larval, and a few in the more advanced stages; but none, to the best of my knowledge, pass the winter in the adult stage, and, so far as I am aware, all the species are single-brooded. The species infesting plants under glass in warm houses have no resting season, successive broods occur throughout the year,

consequently there is a great deal of overlapping—eggs, larvæ, and adult insects occurring at the same time.

A peculiar habit noticeable among many Coccids is that they fix themselves along the midrib and larger nerve bundles of the leaves, where they would naturally get the greatest flow of sap. Mr. F. W. Burbidge, of the Botanic Gardens, Dublin, kindly called my attention to this fact, and in the same communication gives a note on a remarkable habit in *Cryptococcus fagi*, which seems to show that other species of *Fagus* are distasteful to it. I give Mr. Burbidge's own words:—"You may have noticed a curious fact; the two common kinds of weeping beech are grafted by nurserymen on the common beech as a stock. Here we have a tree, the stock of which is infected by the Coccus, but it does *not* infest the weeping beech scion. I showed our plant to a gentleman who has a very fine weeping beech, also grafted as above, and he tells me it is just the same with his tree —stock infected, scion free from the insect pest" (*in lit.*, Oct. 26th, 1900).

The Ovum.

A Coccid deposits its eggs but once during its life, the period varying according to the habit of the species. The time occupied in oviposition is usually of comparatively short duration, but in a few instances it is more prolonged, and may extend over several weeks. Eggs laid in spring and summer hatch before winter, while those laid in the autumn do not hatch until the following spring. The number laid by individual females varies considerably in the different species. So far as my experience goes, the minimum is reached in the sub-family *Diaspinæ*, which in *Mytilaspis pomorum* gives, approximately, an average of about twenty-five, the maximum being probably reached in certain species

of Lecanium, in which I have counted between 2000 and 3000*. In form the eggs are more or less narrowly elongate or ellipsoidal, with the sides usually straight and parallel, but in some few instances they are slightly curved (Pl. XIII, fig. 7).

Yellow and pink are the prevailing colours, while in *Mytilaspis pomorum* they are colourless, in *Aulacaspis rosæ*, Bouché, and *Chionaspis salicis* they are crimson, and in *Parlatoria proteus*, var. *crotonis*, Doug., they are dark mauve (Pl. XXXI, fig. 3). A fine white mealy substance (wax) is usually attached to them, but is too sparsely distributed to veil the character or colour of the eggs. In *Pulvinaria*, *Dactylopius*, and other genera the powdery substance is replaced by very long, fine, white, silk-like filaments, of an exceedingly elastic character, which in the former genus, when ruptured by the wind, are carried long distances, appearing in the air like an entangled mass of gossamer webs. As the young embryos mature within the egg the eye-spots become distinctly visible, which generally heralds the emergence of the larva.

Coccids never lay their eggs in exposed situations, as do Aphids and other allied families of the Homoptera, but provide various means of protecting them. In the *Diaspinæ* they are laid beneath the shield-like covering (Pl. XIV, fig. 3; XXIV, fig. 4); while in *Lecanium* the female protects them with her own body. With *Physokermes abietis* they are received into a very peculiar marsupium or pouch, formed by the folding in of the outer epidermis, so that practically the eggs never leave the body of the female. *Orthezia* carries them between the long waxen plates at the posterior extremity of the body, which are specially developed for this purpose.

Numbers of Coccids lay their eggs in sacs formed of white cottony or felted material (wax), which are

* In *Walkeriana pertinax*, Newst., a species recently discovered in British Central Africa, 6258 larvæ were taken from the body of a single female ['Proc. Zool. Soc.,' Lond., 1900, with plate].

either open at the cephalic extremity or completely closed. In *Pulvinaria* the ovisac takes the form of a pad or cushion behind and beneath the parent insect. In *Lichtensia*, *Signoretia*, and *Eriopeltis* they are practically complete, except at the anterior extremity, which is left open for the escape of the young larvæ, while *Eriococcus insignis*, Newst., hermetically encloses herself with her eggs in a very closely felted sac. The "mealy bugs" take less pains than any other of the British Coccids, merely enclosing the eggs in irregular aggregated patches of loose cottony material, which renders the plants they attack so very unsightly.

In the majority of instances the eggs are laid in irregular masses, filling the space provided by the parent insect; but *Ischnaspis filiformis*, Doug., places them transversely side by side, forming a long continuous series up the centre of the puparium or shield. *Parlatoria proteus*, var. *crotonis*, also places them transversely in the puparium, but arranges them in two parallel rows, as shown at Pl. XXXI, fig. 3.

The Larva.

In this stage the sexes are rarely distinguishable, and so closely allied are the larvæ of certain genera, *e. g. Lecanium* and *Physokermes*, that it is almost impossible to separate them.

On hatching from the egg, the larvæ, in the majority of species, remain for a few days huddled together within the covering provided for them, whether it be the cottony or felted sac; or, as in *Lecanium*, the highly chitinised body of their dead parent. On escaping from their birthplace they are very active mite-like creatures, but their period of activity is, in the majority of cases, of short duration, as they quickly settle down upon the food-plant, whether bark, leaf, or fruit, and immediately insert their long hair-like sucking apparatus into its tissues, and suck or

pump up the juices of the plant. The larvæ of the genera *Dactylopius*, *Ripersia*, *Pseudococcus*, and *Orthezia* are active throughout life.

The larvæ are ovate or slightly ellipsoidal, extremely thin and flat, and the segmentation is usually traceable. The eyes are rather large, and placed on or near the margin behind the antennæ. The legs are comparatively short, and placed well within the lateral margin of the body. The antennæ are usually formed of six joints, and possess a varied number of hairs, which in certain genera are sometimes very long. The mouth organs are generally placed a little anterior to the front pair of legs, the rostral filaments, or sucking apparatus, being often so long as to reach almost to the abdominal extremity. A more detailed account is given of the larvæ under the chapters dealing with the various sub-families (Diaspinæ, etc.).

When colonies of the larvæ of *Mytilaspis pomorum* and *Lecanium persicæ* become more or less overcrowded, they will ascend to the leaves, and there settle down as upon the branches. This is particularly noticeable in the latter species, which frequently overflows to such an enormous extent that thousands of them fall away with the leaves in autumn and perish. This is fortunate for the horticulturist, as it materially lessens their numbers. It should be added, however, that I have not found *M. pomorum* on the leaves or fruit except in extreme cases of overcrowding; but with *L. persicæ* this commonly occurs in large colonies, and while there is yet space for them upon the branches of the tree. This remarkable habit possibly points to an earlier habitat on a plant possessing perpetual foliage.

Second Stage.

This in the female is the intermediate stage between the larva and the adult, and in the male the stage between the larva and the pupa.

The female in this stage generally resembles the adult insect (Pl. XX, fig. 5, second stage, ♀; and fig. 4 the adult ♀; Pl. XXV, fig. 11, second stage, ♀, dorsal; and fig. 10 adult ♀, ventral), and although usually much smaller than the adult, in certain genera (*Fiorinia*, *Gymnaspis*, etc.) it attains its greatest dimensions in this stage.

The second stage of the male usually resembles the immature female; in the Diaspinæ by the absence of antennæ and legs (Pl. XX, fig. 7), and in the Lecaniinæ by the retention of these organs.

The Pupa.

The pupal stage occurs only in the male sex, and represents the third stage in the life of the insect. In form it shows the general outline of the future insect (Pl. XX, figs. 8 and 9), has the legs and antennal sheaths free, though as a rule they remain rigid and inert, the insect in this stage being generally unable to move. The only instance in which I have seen a Coccid pupa at all active and able to use its legs was in a single example of *Dactylopius*, sp. (? *citri*), in which case I forcibly removed the insect from its puparium, when it slowly moved about in the ruptured material forming the sac.

A few days prior to the emergence of the male the pupal skin is cast off and pushed out at the anal extremity of the puparium. After this the tips of the wings may sometimes be seen at the opening; and where, as in *Lecanium*, *Pseudococcus*, and other genera, the males possess long caudal filaments, these organs extend from the puparium as long white thread-like appendages. When such conditions are seen the early appearance of the male may be looked for, and should the observer be fortunate enough to witness the emergence, he will find that the insect accomplishes this backwards. The colour of the pupa generally resem-

bles that of the perfect insect, the usual tints being yellow and crimson, or more rarely mauve or brown, etc.

The Male.

The most extraordinary characteristic of this sex is the complete absence of a mouth, which is perfectly obsolete; and the position one would naturally expect to find it in is occupied by a comparatively broad band of dark chitin, on either side of which are usually one or more pairs of comparatively large ocelli. The males are generally winged, but a few species are apterous; and *Chionaspis salicis* possesses both apterous and winged forms—a characteristic decidedly exceptional and unique among British Coccids. The discovery of this interesting fact was made by the writer in 1889.

The alate forms possess only two wings, with a single bifurcate nervure; the lower pair being represented by a pair of halteres, or hooked bristles, which fit into minute turned-up flaps or pockets in the wings. Compared with the size of the insect the wings are rather large, semi-transparent, widely rounded at the tips, and are generally more or less hyaline, the latter character being strongly marked in the common "mealy bug" (*Dactylopius*) of our hothouses, which under certain lights is of a beautiful intense blue. In repose they lie flat upon the body and usually partly cross each other. The segmentation of the abdomen is present, but not very pronounced. The genital armature in the *Diaspinæ* is very long and sabre-like; while in the other British genera it is usually short, and frequently accompanied by two to four long white filamentous appendages.

I have never observed a male Coccid voluntarily take to flight; but have occasionally induced certain species to do so by agitating them with a pointed

instrument, when the flight was somewhat midge-like and sustained.

In a state of nature rain must have a very fatal effect upon these tiny creatures, as in captivity a drop of moisture or a moist piece of glass almost immediately entangles them, and from which I have never seen them able to extricate themselves. Sunlight and dry weather would, therefore, seem essential to them. *Mytilaspis pomorum* and *Aulacaspis rosæ* are very active in the sunshine; while the males of *Dactylopius* and *Pseudococcus* are comparatively sluggish, and will sometimes remain for hours in the same position.

Occasionally this sex preponderates, and this especially so with *Chionaspis salicis* (Pl. D, fig. 1B); but, as a rule, male Coccids are considerably in the minority. Some occur annually, while others do so only at intervals of many years, and numbers of them are still unknown.

Not the least remarkable fact is the occurrence of the males of *Mytilaspis pomorum* on certain food-plants, while they are altogether absent from others. For instance, the males occur freely upon broom (*Cystisus scoparius*), heath (*Erica*, spp.), and bilberry (*Vaccinium myrtillus*); while colonies upon apple trees in this district (Cheshire) have not produced a single male for the last ten years. The absence of the males of *M. pomorum* on apple and other plants is quite universal. The late Mr. Maskell, during many years of close and continued observation, never met with this sex in New Zealand; indeed, so rare has the male been in other countries that it has only once or twice been met with. Is it possible the food-plant can have anything to do with the production of the males? The species is undoubtedly partial to the apple, and is found more abundantly upon it than anything else; while broom, heath, and bilberry are only occasionally attacked!

The times of appearance of the males vary according to the species. The earliest to appear are those of a

species of *Pseudococcus* infesting laburnums, which generally hatch towards the end of March. In May all the indigenous species of *Lecanium* appear, and are then often common upon oak, hawthorn, apple, etc. Early in August *Dactylopius walkeri*, Newst., may be met with sparingly behind the leaf-sheaths of *Dactylis glomerata* and other coarse grass under hedgerows; and towards the end of the month and during September the pretty little yellow male of *Aspidiotus zonatus*, with its black apodema, may be obtained. The latest of all are the curious males of *Apterococcus fraxini*, which emerge in September and October just as the early frosts set in; but this neither lessens their numbers nor their activity, as I have witnessed them searching for the female as early as 8 a.m. after some three or four degrees of frost.

The males of those species infesting plants under glass have no fixed period. They are most abundant in summer, but may be met with throughout the year.

In point of size those of the Diaspinæ are among the smallest, averaging about 1 mm. long and 2 mm. in expanse of wing; while the largest occur in the genus *Lecanium*, and measure, inclusive of caudal appendages, about 6 mm., and 4 mm. in expanse of wing. Compared with the females they are all smaller than that sex, but the disparity in size is most marked in certain species of *Lecanium*, where the large gravid females are at least from fifty to one hundred times larger and heavier than the males. So extraordinary is the difference between the sexes in every respect, that it is hard to realise they are of the same species.

THE FEMALE.

Diversity of form among female Coccids is very great, but all are characterised by the absence of wings, and there is no defined division between the head and the body. With the exception of an

abnormal exotic genus, all are furnished with comparatively large mouth parts, of the same structural design as exists in the larvæ, and they feed by suction, as all other *Homoptera*.

In the sub-family *Diaspinæ* the females are flat and pyriform in shape, resembling somewhat a compressed "top;" they are also invariably apodous, have quite rudimentary antennæ, and the eyes usually represented by coloured patches of pigment. All the species of this sub-family cover their bodies with a shield, composed partly of secreted matter and partly of moulted skins. Certain species possess the power of burrowing beneath the epidermal layer of the food-plant—a habit strongly developed in *Chionaspis biclavis*, which completely buries itself and its shield beneath the thick epidermal layer of the branches of the plants which it infests. Under the shield-like covering (puparium) generally known as the "scale" the female lays her eggs and dies, leaving the space her body once occupied filled with her progeny.

The genus *Conchaspis* has a covering scale very similar in design to those described above, but it is composed entirely of secreted matter, the moulted skins not being employed in its structure. The females are also more highly organised, possessing both antennæ and legs. The only species found in this country was probably imported on orchids from the West Indies.

The Lecaniinæ includes the common "brown scales" (*Lecanium*, spp.), so abundantly distributed throughout the world. Our indigenous species are somewhat generally distributed, while those infesting cultivated plants and fruits are, for the most part, universal pests. With the exception of *L. minimum*, Newst., they are comparatively large insects, varying from the flat ovate or subpyriform *L. perforatum*, Newst., through every grade of convexity to the hemispherical *L. hemisphæricum*, Targ.-Tozz. They are rarely, if ever, active after the larval moult and never so after

completing the second stage. The gravid female in life has the whole ventral surface very closely adhered to the portion of the plant upon which it is fixed; but, as the insect matures and egg-laying proceeds, the ventral surface with the exception of the extreme margin gradually shrinks until it meets the hardened outer skin. Thus the insect becomes a hollow hemisphere filled with eggs, which her dead body continues to protect until the young are hatched, and long afterwards remains attached to the food-plant as an empty shell. This remarkable shrinking process is much less marked in the flat species of *Lecanium;* in the first place there is comparatively little to shrink, but a slight cavity is formed sufficient to protect the few young that are generally produced.

The indigenous species of the hemispherical type of *Lecanium* are generally brightly coloured, possessing a nuptial dress of shaded reds and crimsons traversed by ivory-white markings, which renders them more like galls or berries than living insects. Those of the *hesperidum* and *coryli* type are remarkable for the abnormally long periods of fertility they are able to sustain, generations succeeding each other for years without the intervention of a male. Several species have been under continuous observation for many years without any trace of a male having been seen.

The genus *Pulvinaria* is very closely allied to *Lecanium*, so much so that it is scarcely possible to separate either the larva or adult until the period of parturition commences, when a white pad of wax is secreted behind and beneath the body of the female, which alone gives the key to the genus.

In its larval stage, *Physokermes abietis* is also very closely allied to *Lecanium*, but the adult has neither legs nor antennæ present, and is otherwise a very remarkable insect.

Both British species of *Lecanopsis* are subterranean; *L. formicarum* is found associated with ants, but, from its rarity, very little has been learned of its economy.

Signoretia luzulæ, L. Duf., and *Eriopeltis festucæ*, Fonscol., construct closely felted ovisacs, in which they lay their eggs, and from which they afterwards fall to the ground and perish, leaving a place of exit at the cephalic extremity of the sac as a means of escape for the young.

Asterodiaspis is well represented in our small indigenous *A. quercicola*. It is a very common insect, occurring on oak in many counties, but is apparently less common in certain portions of Northumberland. It is the only British Coccid which makes any attempt at the formation of a gall, though it cannot be said to be a true gall-maker, but yet it has the power of producing deep circular depressions or pits, accompanied by a very marked concentric swelling upon the terminal branches of the oak. The male has been described, but has not so far been met with in England.

Eriococcus makes a very closely felted sac, which in *E. insignis*, Newst., holds together almost as a woven fabric. *E. devoniensis*, Green, not only makes a well-formed sac, but also has the power of contorting the shoots of the *Erica* which it infests, causing little rosettes of leaves at the tips of the twigs.

The mealy bugs are the most familiar of all Coccids to horticulturists. Only one* indigenous species is at present known, viz. *Dactylopius walkeri*, Newst.; *D. citri*, Boisd., and *D. longispinus*, Targ.-Tozz., are the common pests of our hothouses.

The genus *Ripersia* is closely allied to *Dactylopius*, but has fewer joints to the antennæ, and most of the species are of subterranean habits, living on roots of plants in ants' nests. No males of the genus have yet been observed, and it would be of the greatest value and interest to discover them.

The beautiful species of the genus *Orthezia* are readily distinguished from other Coccids by the body being covered with thin plates of pure white wax of an exceedingly fine texture, which overlap and form a

* *D. hibernicus*, Newst., and *D. radicum*, Newst. are now added.

beautiful symmetrical design. I have elsewhere noted these insects carry their eggs and young between the anal plates, which act as a sort of marsupium or cradle.

Of the much-dreaded fluted scales, *Icerya ægyptiacum*, Douglas, was introduced (? from India) to a garden in the London district; but, thanks to the discoverer, it was speedily eradicated, and, I believe, has not since been met with. Of course it is always difficult to say how a newly introduced pest may act; but, given favourable conditions such as it would meet with in our hothouses, I see no valid reason why the insect should not thrive and be equally destructive among our exotic plants as other aliens have been.

The Respiratory System.

A young female *Lecanium* affords an excellent example for the study of the respiratory system. The branched tracheæ can be plainly seen to penetrate the body, and to be connected with four comparatively large openings or spiracles placed equidistantly on the ventral surface of the body, well within the margin and near the line of insertion of the legs. Extending from each of the spiracles to the outer margin of the insect is a deep semicircular channel, which is almost invariably filled with fine white wax in a powdery form, which probably acts as a filter, and prevents the ingress of excessive moisture. If a gravid female be removed from its food-plant it will almost invariably leave behind it a white scar or mark, indicating its outline and the exact position of the four channels leading to the spiracles.

In the remarkable exotic genera *Stigmacoccus*, Hempel, and *Perissopneumon*, Newstead, the two pairs of ventral spiracles are supplemented by a series of others, arranged along the margin on the dorsal surface. In the former there are eight, and in the latter seven pairs, but this peculiarity does not exist in any other Coccid.

Natural Products of the Coccidæ.

The "cochineal insect" (*Coccus cacti*), which is a typical Coccid, has been met with in this country on certain species of cultivated cacti. Before the discovery of aniline dyes this species afforded us a most valuable dye product, which, although superseded to a very great extent, is still largely imported for use in dyeing valuable fabrics such as silk; and it is, I believe, used exclusively as a crimson dye for colouring sweetmeats and confectionery. A species of *Kermes*, in shape remarkably resembling a large crimson holly berry, is also imported for the value of its dye, for which purpose it has been used from time immemorial. *Ericerus pe-la* is a Coccid of some value to the Chinese. This insect, like many others (including British species), secretes a pure white wax, which in China is collected and made into candles for special use. In India similar use is also made of a wax obtained from a species of Ceroplastes (*C. ceriferus*).

In South Africa the remarkable subterranean *Margarodes trimeri*, Giard., is extensively collected and made up as personal ornaments. Quite recently Mr. C. P. Lounsbury, Government Entomologist at Capetown, kindly sent me a necklace composed of about 700 of the outer pearly shells of this Coccid, which he says "are sold locally as native curios under the name of 'ants' eggs.' The shells are found in the mountains about one hundred miles from here. The living insect is rare, but I have found a few on the roots of a *Rhus* after long searching. New shells are clear yellow." *Margarodes* is also met with in other parts of the world, and is occasionally sent to this country in collections of shells under the name of "ground pearls."

Tachardia lacca furnishes us with the invaluable

product known as "lac," which forms a basis for varnish, French polish, and many other equally important materials. It is usually imported into this country upon the twigs or small branches of the trees upon which the insects have secreted it, and is known commercially as "stick lac," which after treatment is made into "cake lac," and finally into "shell lac," a material known to almost every schoolboy. Being of such value to us, I have ventured to give a photograph of examples of the "stick lac" (Pl. A, fig. 1), the history of which may be briefly described as follows:

"Like all other Coccids, the young (*larvæ*) are active; they are at first very tiny creatures, resembling mites, and are generally spoken of by the horticulturist as 'lice.' These young arrange themselves in groups of various dimensions round the twigs of the food-plant, and, having settled matters satisfactorily as to space, insert their thread-like sucking-tube (mouth) into the plant tissues, and pump up the sap of the tree. At the same time they commence covering their bodies with the peculiar 'lac' which, by the time they are fully developed adult females, assumes the form and size shown in the illustration. By taking a hot knife a transverse section of the material may easily be made, when it will be seen that the covering material or 'lac' is not a solid mass, but is honeycombed by large, somewhat ellipsoidal cells, each of which was once tenanted by a single female. . . . . If we examine a female we find she is shaped somewhat like the cavity in which she lives, with the cephalic portion bearing the mouth parts touching the bark at the narrow end of the cavity, and the abdominal extremity at the opposite end having connection with the exterior by means of a minute perforation; and she is destitute of legs and antennæ, etc. Where she has lived she dies, leaving as a legacy the wonderful product which she manufactured during life, and which all the world over is of so great importance in commerce. And this is not all; the bodies of the females also

furnish an excellent dye, which in former times was of much value also."*

Honeydew.

The honeydew secreted by Coccids is a clear glutinous substance, appearing on the leaves of plants as a thin coat of transparent varnish. No analysis of it has been given, but from its attractive qualities to insects it is undoubtedly analogous to that produced by the Aphids. It is rarely found to accompany the shield-bearing *Diaspinæ*, but the amount secreted by large colonies of various "brown scales" (*Lecanium*, spp.) and "mealy bugs" (*Dactylopius*, spp.) is sometimes enormous.

In the Lecania the greatest amount of secretion takes place immediately prior to and during the period of parturition, and with the indigenous species it occurs chiefly in May and the early part of June; but with those species attacking plants under glass it occurs indefinitely, and is generally present where large colonies of Coccids are allowed to remain unmolested. The females only have the power of secreting the honeydew, which passes out through the anal opening, and may therefore be considered as the natural excreta of these insects. In his account of New Zealand "scale insects" (1887), p. 16, the late Mr. Maskell mentions a special organ for the secretion of this substance as a "cylindrical tube exserted from the ano-genital orifice after the manner of a telescope, the furthest extended tube being the most slender. This organ, extremely difficult of detection when not in use, except in the single genus *Cœlostoma*, Mask., is at intervals pushed out to its full extent, and at its further extremity there appears a minute globule of yellowish, nearly transparent glutinous fluid, which

* Newstead. "Injurious Scale Insects and Mealy Bugs of the British Isles," 'Royal Hort. Soc. Journal,' vol. xxiii, pt. 3, 1900.

rapidly expands like a soap-bubble, and then, suddenly breaking, falls in spray on the leaf beneath." I should consider this "cylindrical tube" only as a part of the anal opening, and not as a special organ of secretion. I have only once seen a Coccid—a young adult female of *Lecanium ciliatum*—in the act of secreting honeydew, when the act was involuntary, and undoubtedly caused by bringing light pressure to bear upon the back of the insect. A cylindrical tube was exserted, and a comparatively large drop of fluid appeared exactly in the way Mr. Maskell has described.

Shortly after the honeydew has been deposited upon the plants it is almost invariably attacked by a microfungus, well known to gardeners and horticulturists as the "soot fungus" or "black smut" (*Meliola*, sp.), the mycelium and spores of which rapidly penetrate every part of the honeydew, converting it into a thin black layer or soot-like deposit. It is true the fungus does not penetrate the plant tissues or set up any disease in them, but the appearance of the fungus upon peaches and nectarines, or upon tender hairy-leaved plants, is unsightly if not injurious, and is much dreaded by cultivators of fruits and flowers, and the remedy for which lies in the destruction of the Coccids.

I should say the honeydew is as attractive to nectar-feeding insects, and especially the aculeate *Hymenoptera*, as that of the Aphides. I may especially mention the hive bee (*Apis mellifica*), *Bombus*, spp., *Andrena*, spp., *Halictus*, spp., and, with the exception of *V. crabro*, every member of the *Vespidæ*, including many examples of the rare *V. arborea*, Sm. The foregoing observations were chiefly made in the gardens of Mr. Alfred O. Walker, Nant-y-glyn, Colwyn Bay, N. Wales, who with myself, during the years 1884—1886, made many interesting captures, the exact spot being a warm sloping bank some fifteen to twenty yards long, which was practically covered with *Cotoneaster microphylla*, almost every branch of which harboured colonies of the common brown scale of the

currant (*Lecanium coryli*, Linn.). In May these insects secreted enormous quantities of honeydew, which immediately became attractive to insects, but more especially so to the wasps.

Ants are also attracted by the honeydew, and in greenhouses it is no uncommon occurrence to find them swarming over plants infested with Coccids, their sole object being apparently to collect the sweet secretion which may have fallen upon the leaves. "Mealy bug" (*Dactylopius*, spp.) is so frequently attended by ants, that in the minds of the gardener the two insects are generally associated. It is well known, however, that the ants are not directly destructive to the foliage of plants, but they are credited with carrying the "bug" to other plants, thereby spreading the infestation over larger areas than the Coccids would of themselves. I have never seen ants voluntarily carry "mealy bug" from place to place, but I must admit it is quite possible they may inadvertently do so, and this without any serious impediment to their progress, the larvæ of the Coccids being so minute that they could easily attach themselves to the legs or body of the ants, and I have little doubt that this sometimes happens.

I think it is tolerably certain that ants also extract the honeydew direct from the bodies of the Coccids, and in 1893 I gave the following evidence in support of this: *

"During the year 1890 a naturalist friend called my attention to a colony of ants which he said were constantly visiting some 'American blight' on his apple trees, evidently for the purpose of obtaining from them 'honeydew' or other liquid, which he said he had seen them extract on one or two occasions. On visiting the locality, the so-called 'American blight' proved to be a species of *Pseudococcus*, and the ants the common *Formica flava*. There were very many of the Coccids, all adult females, just about to construct their ovisacs; these were visited by a variable number

* 'Entomologist's Monthly Magazine,' 1893, p. 78.

of ants, whose *modus operandi* was as follows:—Three or more generally surround a single Coccid; one of them, usually the first comer, would place its front legs on the back of the Coccid, with its head in the same direction as the latter; it would then commence to stroke the back with its front legs and antennæ; when tired of this a second ant would repeat the process, and so on, each awaiting its turn. Although I watched them for some time I did not see them extract anything from the Coccids. Judging from what I could perceive, the Coccids were rarely free from the ants; they appeared much harassed, and had evidently tried to protect themselves by wedging their bodies into the smallest crevices that would admit them; and through the constant visits of the ants the bodies of the Coccids were almost denuded of their mealy covering."

The mutual relations of ants amicably dwelling with subterranean Coccids scarcely come under this heading, but it is of much importance, and those interested should read Mr. W. W. Smith's interesting papers on "The Origin of Ants' Nests,"* as observed by him in the New Zealand species. Unfortunately I have little to contribute to this subject; but, in the light of what has already been stated with regard to ants being attracted by Coccid-secreted honeydew, it seems reasonable to infer that the subterranean Coccids found dwelling with ants may also secrete a sweet fluid, and if so would in a very great measure account for the interdependence of these insects.†

* 'Entomologist's Monthly Magazine,' S.S., vol. iii, pp. 60, 307.

† In N. Konkan, India, Mr. Wroughton has recently discovered a remarkable Coccid (*Perissopneumon ferox*, Newst.), which he says is "kept in special nests built for the purpose by Œcophylla smaragdina" [Newst., 'Ent. Mo. Mag.,' vol. ix, p. 251].

COURTSHIP.

In a family possessing such degenerate females, which for the most part are inert and unadorned, and where, as in the Diaspinæ, they are completely hidden by their shield-like covering, one would naturally infer that the choice of selection, if existing at all, would remain with the more or less brightly coloured active males. This apparently holds good in the majority of cases, but there are certainly exceptions among the *Dactylopiinæ*, where the female seeks the companionship of the male, and travels comparatively long distances to do so.

The females of certain species of *Lecanium* display a nuptial dress of reds and shaded crimsons with white zebra-like markings, which renders them most conspicuous, and it is highly probable that these colours may be attractive to the males.

One of the most remarkable habits of courtship occurs in a species of *Pseudococcus* inhabiting laburnums, in which the female is to all appearance the active party, and assiduously conducts the courtship. In winter the sexes live apart, the females inhabiting the smaller branches of the tree, while the males, still in the pupal stage, and enclosed within their cocoon-like sacs, are packed together on the sheltered side of the tree trunk. During the first warm sunny days in March the females become very active, and may be seen travelling down the branches on to the tree trunk, where they appear continually to search for their partners. So anxious do they appear to reach the breeding ground that they precede the emergence of the males by several days. In due course, generally after a weeks' sunshine, the dingy-coloured and somewhat sluggish males put in their appearance, and may be seen leisurely walking over the sunlit bark. After fecundation the females return to the branches, often

quite high up, and there in summer-time construct their ovisacs and lay their eggs. In the autumn the larvæ separate, the females remaining on the branches while the males descend to the tree trunk to pupate. I believe no such habits have been observed in any other species; indeed, our knowledge of the habits of these insects is very limited, and there is a wide field of research open to the student of nature.

In *Chionaspis salicis* the bright orange-red male divides his favours among the females capriciously. Its success in finding the females appears to depend on the delicate sense of touch in the antennæ and long sabre-like genital armature. Frequently several males will surround a single female puparium, but there appears to be no strife between them. Each gives the other a place, while all are intent on discovering the passage between the scale-like covering and the bark which leads to the hidden female. This accomplished, the armature is inserted to its full length beneath the covering scale, and its course is apparently aided by the insertion of the posterior legs in the way shown in the illustration (Pl. XIX, fig. 3 *a*).

Migration, Distribution, Acclimatisation, etc.

As adult female Coccids are unable to fly, or usually to walk, it is only the minute larvæ which can migrate, and that only in small areas; this accounts for the enormous isolated colonies of these insects which only too frequently occur on a single plant or tree. Yet, strange to say, there is no family of insects that has a wider geographical distribution than the Coccids. Take, for example, the common "mussel scale" of the apple (*Mytilaspis pomorum*), a species supposed to be of Palæarctic origin. It occurs as a pest in almost every part of the world where the apple is cultivated—in Europe, North and South, the United States, New Zealand, Australia, North Africa, and probably many

other places. Many of the species living here under glass are far more injurious in the open air, in sub-tropical and other countries, than they are in the artificially heated plant-houses in this country. Of these we may quote the injurious "mealy bugs" (*Dactylopius*, spp.), which, even as near home as Southern Europe, are destructive pests to orange trees and a host of other plants.

The occurrence of certain species of Coccids in countries so widely separated and so completely isolated has undoubtedly been brought about by the importation of plants, which is now so rapidly carried on in all parts of the world. The fixed, inert character of the Coccids, the minute size of their larvæ, render them the easiest of all insects to be carried long distances; and what is equally important, on their arrival in a new country they may easily escape the eyes of the untrained horticulturist, who, although he may be "dead on all scale and bug," would be unable to detect the almost microscopic young which might be lurking in a hundred places. To take a case in point, I will quote my observations on the introduction into this country of a Japanese Coccid ('Gardener's Chronicle,' vol. xxiv, pp. 245, 246):—"In January of the . . . . year (1898) a consignment of several hundred Japanese cherries (*Prunus pseudo-cerasus*) was imported into this country from Japan, which ultimately fell into many hands, and were disseminated over the British Isles without any knowledge they were badly infested with 'scale.' In the following April two of the plants from the consignment were submitted to the writer for the purpose of identifying the insects upon them, which proved to be the destructive *Diaspis amygdali* of Tryon." *

On inquiry it was found that the greater number of plants of this particular batch (100) had been planted out of doors since the time of their arrival, and, as the examination proved, the insects were not in any way

* Now considered a syn. of *Diaspis* (*aulacaspis*) *pentagona*. T. T.

affected by their change of climate, but appeared in a perfectly healthy condition.

Information was at once forwarded to the correspondent as to the serious nature of the pest, with a request that the plants be at once destroyed. This, however, was not carried out, but measures were taken to destroy the insects by dipping the whole hundred plants in a hot paraffin emulsion, in the hope the insects would not survive such drastic treatment. And so the matter rested until June 3rd, when the correspondent again informed the writer that a recent examination of the plants had been made, when it was found the insects were still living, and it was thought another application of the insecticide would have completely destroyed them, but instead of temporising the plants were all burnt. This was much the wiser plan, as we have the satisfaction of knowing the insects on this particular patch of plants are completely destroyed, and this too before the young ones (larvæ) had time to hatch. Thus we see that a number of horticulturists and nurserymen evidently failed to detect the presence of this pest, for it surely cannot be supposed that they would knowingly have allowed the infested trees to be distributed through various parts of the British Isles.

The introduction of the preceding species occurred at the time when horticulturists in every part of the world were only just getting over the "San José Scale" scare, the magnitude of which had not been equalled since the memorable days when the possible introduction of the Colorado beetle was so much discussed. Although the San José Scale (*Aspidiotus perniciosus*, Comstock) has, to the best of my knowledge, never been met with in this country, I think it would be well, in the interests of horticulture, to here place on record a brief account of what took place in this country with regard to the possible introduction of the pest into the British Isles. Germany first raised our apprehensions in February, 1898, by condemning a cargo of Californian pears, which were

placed in quarantine, and subsequently, I believe, the Hamburg Senate granted permission for "the further export of the consignments to England."

This led to an inquiry by the hon. member for Mid-Oxfordshire (Mr. Morrell), and on March 2nd "Mr. Lambert asked the President of the Board of Agriculture whether in cases of American pears imported into Hamburg large quantities of live scale insects were found, which were quite capable of contaminating the orchards of that country, and whether any danger of like infection from similar causes existed in this country.'

Mr. Long: "The official information which we have received from the German Government goes to show that the reply to the first inquiry is in the affirmative. With regard to the second, I cannot say there is no fear of the arrival of the pest in question in this country, and I am in communication with experts on the subject with a view to ascertain whether any practical steps could be taken by us in the interests of British fruit-growers."* On the day previous to this reply (March 1st) I received a telegram from the Board of Agriculture summoning me for conference at Whitehall the next day, and which I attended. On the 24th of March following the secretary (the Hon. Walter Long, M.P.) kindly invited me to attend a special committee meeting of the Board of Agriculture, held at the House of Commons. The discussion which took place at both meetings was either directly or indirectly in connection with the "San José Scale Insect." I was able to inform the Department that *Aspidiotus perniciosus* had certainly not established itself in this country either upon fruit-trees or cultivated plants of any kind, whether grown in the open air or under glass, or upon indigenous plants; and further, that should the species be inadvertently introduced into this country on fruits or plants I did not think it would be at all likely to establish itself on fruit-

* 'Standard,' March 3rd, 1898.

trees in the open air any more than the "mealy bugs" and numbers of other injurious Coccids from other countries living under similar climatic conditions had done. Coming, as the species does, from a subtropical climate, I really do not think it would long survive out of doors in our cold, damp climate. I was present also at a meeting of the Entomological Society of London, held March 2nd, when a discussion took place with regard to the reported introduction of this pest, and was glad to have my views supported by Mr. R. McLachlan, F.R.S., and other Fellows of the Society who were present. Furthermore I also received the following communication from Dr. L. O. Howard, the entomologist of the United States Department of Agriculture, Washington, still further strengthening my views with regard to the acclimatisation of the species in this country :—"I am glad you take the stand you do about introduction into England. I honestly do not think that the insect would thrive there out of doors, although I may be mistaken. No doubt the insect could reach you on California pears, and in my mind there is no doubt as to the accuracy of the German statement that it was found at Hamburg, but of course it takes an expert to distinguish it from the closely related species of *Aspidiotus*, and the ordinary observer is very apt to mistake the small spots produced by the fungus, *Entomosporium maculatum*, for this insect" (*in lit.*, March 14th, 1898).

Superficially the San José scale insect differs but very little from our indigenous *Aspidiotus ostreæformis*, but structurally they are very unlike. Photographic illustrations of both these species are shown side by side on Plate B, figs. 1 and 2 respectively.

The danger to English horticulturists from the introduction of injurious Coccids lies for the most part with our cultivated fruits and flowers under glass, where, in the absence of natural enemies, they thrive and multiply, causing us annoyance, disappointment, and loss.

It is highly improbable that the Coccids from warmer

countries will be able to establish themselves outdoors in the British Isles, but all species introduced from temperate regions should be regarded with suspicion and dealt with accordingly.

Besides the dissemination of Coccids on plants by human agencies, the minute larvæ may sometimes be carried long distances by the wind and birds, and also by various insects. Otherwise the distribution of the Coccids would necessarily be of a very limited character.

Natural Enemies of the Coccidæ.

In foreign countries certain of the *Coccinellidæ* play a most important part in keeping the Coccidæ in check. The *Vedalia cardinalis* (a small ladybird beetle, resembling somewhat our *Coccinella bipunctata*), of Australian origin, is world-famed for its usefulness in destroying the *Icerya Purchasi*, or "fluted scale." A few years since the United States Department of Agriculture imported this insect into certain districts in the States, where it has done magnificent work in checking the ravages of the *Icerya*. It has also been introduced into Egypt and South Africa with the same excellent results. So far the Coccinellidæ are not known to attack the Coccidæ in this country, although they are known to feed extensively on the plant-lice or Aphidæ.

Brachytarsus varius and *B. scabrosus* are the only beetles at present known to be parasitic on the Coccidæ of this country. In August, 1890, I bred specimens of the former species from *Lecanium*, sp., and subsequently from *Physokermes abietis*, Geoff., both taken at Delamere Forest, Cheshire. As it is no uncommon occurrence to find ruptured female Lecania, I am of opinion *Brachytarsus* feeds more extensively upon Coccids than may be generally supposed.

I have occasionally observed the lace-wing fly (*Chry-*

sopa, sp.) on beech trunks infested with *Cryptococcus fagi*, Barensp., but have never found the larvæ feeding upon the Coccid.

On one occasion I found a number of specimens of a species of Thrips amongst the thick cottony ovisacs of *Cryptococcus fagi*, but for what intent I cannot say. It is just possible they may have been feeding upon the Coccids; but most probably they were in hiding, and that they found near at hand abundance of vegetation suitable as food.

The insects which commonly infest the Coccidæ are a family of the Hymenoptera, chiefly belonging to the Chalcididæ, and are allied to the bees and wasps; they are very minute, and many are of a bright metallic green colour. These parasites chiefly infest the large Lecania, and are capable of materially altering the form and external character of these insects. In 1891 ('Entomologist's Mo. Mag.,' S.S., vol. ii, pp. 267, 268) I called attention to this, and it may be useful to quote what was then stated:

"I have examined a good many species of *Lecanium*, and find that several are subject to considerable variation in the form of the scale (♀), and this entirely from the attacks of internal parasites. Of these there are at least two species* very common, and both, so far as I have been able to trace, produce abnormal swellings, peculiar to the species, on the dermis of the host. The most important of these is that which produces one, two, or more large tubercular swellings—generally two; when the latter is the case the scale appears quite symmetrical, the swellings being on either side of the dorsum, opposite to each other. When there is but one large tubercle it is invariably situated on one side of the dorsum, thus giving the scale (♀) a "lop-sided" appearance, which at once attracts the eye as curious and unusual. I find that each of these tubercular swellings, if examined in season,

* I am now of opinion the difference was sexual, and that the species causing the swelling is the *Blastothrix sericea*, Dal.

as a rule contains a single parasitic larva, or if more are present there is but one large swelling, which gives the scale (♀) a . . . . gibbous form. . . . . I should add that the portions of the dermis affected by the parasites are devoid of the ordinary reticulation, and in the specimens which are much swollen the integument becomes almost transparent. It is somewhat exceptional for the perfected parasites to escape through the dermis by making and leaving the usual perforations; they more frequently leave the body of their host through the anal cleft, as there is no other means of escape if they have not made such for themselves. When this is the case they seem to have completed their metamorphoses below the ventral skin of the host, thus the scale remains apparently intact, and one can easily see how such specimens would appear perfect; they, however, have had the whole interior eaten away, but when the parasites escape through the dermis the ventral surface generally remains entire. . . . . The foregoing is sufficient to show that the greatest care should be exercised to select specimens free from parasites for description; for while some of these may not materially affect the exterior of the scale (♀) they are quite capable of malforming the antennæ and legs, especially such species as feed upon the larvæ and ova when in the scale." It is a remarkable fact, but, as in many similar cases, the parasitic larvæ rarely cause the death of the host until the very last stage is reached. It is no uncommon thing to find a parasitised female laying apparently her full complement of eggs, but the latter sometimes fall a prey to the parasitic larvæ.

In the Lecania the earliest external sign of parasitic disease is usually indicated by the yellowish colour of the insect, and later by the swollen appearance of the integument, which form it usually retains, but in many cases assumes the single or double mammiform character.

The following is a list of the Hymenopterous para-

sites, all of which have been kindly identified by Dr. L. O. Howard, of the United States Department of Agriculture.

Aphycus, sp.—This is a pretty little insect, having a bright orange thorax and head, with a dark apodema and a black collar. Several specimens were reared from a species of *Lecanium* infesting blackthorn at Wrexham, North Wales, July, 1891. Unfortunately the antennal flagella were wanting in all my specimens, and all that Dr. Howard could say of them was that the species is probably new, and that it belongs to neither of the two known European species, namely, *A. punctipes*, Dalm., and *A. hederaceus*, Westw. Apparently this species does not actually kill its host, but materially reduces the productive power of the Coccid.

Blastothrix sericea, Dalm.—This species is the most widely distributed and the commonest of the British Coccid parasites, but apparently confines its attacks to the indigenous Lecania. It has been reared freely both by Mr. J. W. Douglas and myself from specimens infesting a variety of trees and shrubs. The larvæ of this species also feed upon the eggs of the Coccid.

Coccophagus, sp.—Two specimens only were bred from *Lichtensia viburni*, taken at Llandaff, and these were unfortunately mutilated, and could not be determined with certainty. As *L. viburni* is seldom attacked by parasitic insects the species is probably a rare one.

Encyrtus festucæ, Mayr.—Infests *Eriopeltis festucæ*, but is not an abundant species, and affects a very small percentage of the Coccids.

Encyrtus scaurus, Walker, is very abundant at Delamere, Cheshire, infesting quite 50 per cent. of *Physokermes abietis*, Geoff.; but I have not met with it in other localities where this Coccid is also common. It does not materially alter the form of its host, but perforates the dermis and makes it abnormally thin.

Encyrtus, sp.—This infests the common Rose Scale (*Aulacaspis* [*Diaspis*] *rosæ*), causing the female to swell and the skin to become highly chitinised, so that

after death it retains its form indefinitely. The parasitised insect rarely lays eggs, and the character of the pygidium is often much changed. This minute parasite is exceedingly active, and in captivity spends most of its time on the glass lid of its cage endeavouring to escape; occasionally I have seen it stop at a larva, puncture it, and apparently lay an egg in its body. The moment the larva is pierced it stops, and for a while remains perfectly still, but afterwards proceeds on its journey as if little or nothing had happened.

Encyrtus (*Aphycus*) *papus*, Walker.—I have bred this parasite freely from *Pseudococcus*, spp., obtained in Cheshire, at Weston-super-mare, and at Ringstead in Norfolk. In the latter locality large masses of the female ovisacs almost covered the main stems of the gorse (*Ulex europæus*), and I noted that in such colonies it was difficult to find an unparasitised female or ovisac, while the single isolated ovisacs were practically immune. The cause of this partiality for masses of the female ovisacs, and not for the isolated examples on the leaves and small branches of the bushes in quite exposed situations, is, I think, due to the fact that the latter are such perfect imitations of bird-droppings that they thereby escape detection from their insect enemies. (See Plate C, fig. 1, *a*, *a*, immune examples; *b*, *b*, parasitised colonies. From a photograph taken from life.)

Of the remaining parasites Dr. L. O. Howard kindly writes, "That from *Ripersia* comprises apparently two forms, the one a species of *Cerchysius;* the other apparently represents a new genus not far from *Dinocarsis*. From the *Pseudococcus*, sp., you have also bred specimens of *Lygocerus hyalinatus*, Tomson (according to Ashmead), but this is probably not a true parasite of the *Pseudococcus*, but rather of some dipterous larva, which itself, perhaps, preys upon the Coccids" (*in lit.*, November 6th, 1899).

The time of the appearance of these hymenopterous parasites is simultaneous with the larvæ of their host, and, although so minute, the latter are immediately

parasitised. In the majority of species this occurs in July and August. The parasitised Coccid larva continues to live without any apparent signs of the hidden enemy through the winter and early spring. It is not until the insect has reached its penultimate stage that the imprisoned parasites, as a rule, make any external signs of their presence in their host. It is possible, therefore, that the eggs of the parasite may lie dormant until the insect has almost matured, when the parasitic larvæ make their escape, and, after sucking up the life-giving juices of the unfortunate Coccid, finally pupate within its body, and eventually escape, just at the right moment when the newly hatched larvæ are abroad, and, as in the case of the Diaspinæ, before they have been able to protect their bodies with the secretiony coverings.

Birds.

We have little or no information from foreign sources to show that Coccids are devoured by birds; and coccidologists are either altogether silent on the subject, or agree that vertebrate animals rarely make attacks on these insects.

Mr. Maskell* says "birds as a rule do not care to eat them. The 'blight-bird,' or white-eye, *Zosterops lateralis*, has been noticed in this country pecking about in holly hedges infested by *Lecanium hesperidum*; but it is not absolutely certain whether it was eating the Coccids or other more easily picked-off insects on the plant, such as *Psocus*, which is very commonly observed among Coccids. And other birds seem not to devour them at all." Mr. Green† writes, "Birds are sometimes supposed to play an important part in the warfare against scale insects, but I am inclined to think that their usefulness against this particular class of insect pests has been overrated. I have watched

* An Account of New Zealand Scale Insects, 1887, p. 20.
† The Coccidæ of Ceylon, 1896, p. 4.

many of our insectivorous birds in Ceylon, and I have never found them attracted by the plentiful supply of insect food spread before them in a field of 'buggy' coffee. There is a particular aroma about many of the Coccidæ that is possibly distasteful to birds."

Taken as a whole, it is quite safe to say the Coccidæ are an offensive-smelling family of insects, which possibly accounts for their comparative immunity from the attacks of birds and other vertebrates; but, as in all other families of insects, there are undoubtedly exceptions.

Here in England I have proved beyond doubt that certain insectivorous birds feed very extensively upon Coccids, and first called attention to this in the Entomologist's Monthly Magazine (S. S., vol. vi, pp. 84, 85, 1895) by giving the results of certain post-mortem examinations. Since that time I have continued my researches in the same direction, with the result that I am able fully to substantiate the evidence there given.

Below are given in a tabular form the results of my post-mortem examinations, together with a summary and remarks upon the species found.

BLUE TITMOUSE (PARUS CÆRULEUS, LINN.).

	CONTENTS OF STOMACH.
♂, Cheshire, Jan. 24th, 1900.	One specimen of *Mytilaspis pomorum*; quantities of bud-scales, and fragments of small Coleoptera.
♀, Cheshire, Jan. 24th, 1900.	Fifty-five specimens of *Mytilaspis pomorum* with about an equal number of wing-cases of small weevils (Coleoptera), and a quantity of fragments of wheat grains.
♀, Cheshire, Feb. 2nd, 1894.	*Aspidiotus zonatus*, many; *Asterodiaspis quercicola*, very many, almost filling the stomach. There were also a few remains of a species of Micro-Lepidoptera and remains of small Coleoptera.

♀, Cheshire, Feb. 2nd, 1894.	Four specimens of *Mytilaspis pomorum*; also fragments of bud scales and particles of maize.
♂, Cheshire, Feb. 7th, 1900.	Thirty-six specimens of *Mytilaspis pomorum*, two brown pupa-cases of small Dipterous insect, and a quantity of particles of wheat grains.
♂, Cheshire, Feb. 7th, 1900.	Fifty-three specimens of *Mytilaspis pomorum*, a few fragments of small Coleoptera, and wheat grains.
♀, Cheshire, Feb. 7th, 1900.	One specimen of *Mytilaspis pomorum*; several small spiders in fragments; apple rind, and particles of wheat grains.
♂, Cheshire, Feb. 7th, 1900.	One specimen of *Mytilaspis pomorum*; remainder filled with minute fragments of a hard black fungus, also found in an example examined January 24th, 1900.
Sex ?, Cheshire, Feb. 7th, 1900.	One specimen of *Mytilaspis pomorum*; a few bud-scales, and particles of wheat grains; rest of stomach filled and unusually distended with fragments of the same hard black fungus found in the previous examples.
Sex ?, Cheshire, April 3rd, 1894.	*Asterodiaspis quercicola*, many; also numerous Cynips, and larvæ of Micro-Lepidoptera.

The above are selected from twenty-one post-mortem examinations made; four in January, thirteen in February, two in April, and two in July.

The maize and wheat had undoubtedly been procured from the farm-yards in the localities from which the birds had been obtained. Of all the Paridæ the blue titmouse in winter feeds more extensively upon corn than any other species.

LONG-TAILED TITMOUSE (ACREDULA CAUDATA, LINN.).

	CONTENTS OF STOMACH.
♂, Cheshire, Feb. 22nd, 1894.	*Asterodiaspis quercicola*, a few; also many fragments of small weevils (Coleoptera); wings of Hymenoptera, and the remains of two small moths (Lepidoptera).
♂, Cheshire, Feb. 24th, 1894.	*Asterodiaspis quercicola*, a few; also many small weevils (Coleoptera); small moths (Lepidoptera), and a wing of *Psylla*, sp.

Selected from four post-mortem examinations made; one in January and three in February.

JACKDAW (CORVUS MONEDULA, LINN.).

	CONTENTS OF STOMACH.
♂, Cheshire, April 15th, 1895.	*Lecanium*, sp., two specimens of adult females. Also many *Chrysomela staphylæa*, *Otiorhynchus sulcatus*, *Sitones*, sp., and many other fragments of Coleoptera. Oats from horse-dung; a few feathers from its own breast; many small pebbles, and a No. 7 gun-shot. The latter had been taken in lieu of a pebble.

Selected from two post-mortem examinations of the same date and from the same locality.

I have thought it advisable to give the whole of the contents of each stomach *found to contain Coccidæ*, making thereby a complete register, which will enable us to form conclusions as to whether the birds were pressed by hunger to eat these insects or otherwise. The results of the post-mortem examinations show that four species of Coccidæ were eaten by birds, viz.

1. *Aspidiotus zonatus* (puparium containing ♀ and eggs).

2. *Mytilaspis pomorum* (puparium containing ♀ and eggs).
3. *Asterodiaspis quercicola* (puparium containing ♀ and eggs).
4. *Lecanium* (adult ♀).

And from observations in the field I am able to add—

5. *Chionaspis salicis* (puparium containing ♀ and eggs).
6. *Pulvinaria ribesiæ* (immature ♀).

1, 2, and 5 belong to the sub-family Diaspinæ. Of these, *Aspidiotus zonatus* is one of the most perfect examples of protective resemblance among British insects, and even to the practised eye of the collector is with great difficulty found during the winter months, when its shield-like covering becomes almost indistinguishable from the dark brown or blackish bark of the oak on which it lives. It is a very generally distributed insect, but never, to my knowledge, occurs in sufficient numbers to cover the branches of its food-plant, as do many species of Coccidæ. This is not to be wondered at, as it is also much subject to the attacks of hymenopterous parasites.

Mytilaspis pomorum is not only an abundant insect, but is the most injurious of all the indigenous Diaspinæ. It is a much more conspicuous insect than 1, but the colour of its scale harmonises very well with the bark of the tree on which it lives, and when the colonies become overcrowded, as is often the case, they are much more difficult to detect. This species is almost immune from the attacks of insect enemies. I have occasionally found a perforated scale, denoting the escape of a parasite, but such instances are very rare. On the other hand, we have abundant evidence from the post-mortem examinations to show that the blue titmouse feeds extensively upon this insect during the winter months, and that out of twenty-one examinations ten stomachs were found to contain examples of

this Coccid. With the aid of good binoculars I have also seen the tree creeper (*Certhia familiaris*) and the marsh titmouse (*Parus palustris*) readily pick off the insects from apple trees in the gardens of the Chester neighbourhood. The removal of the scales invariably leaves a white mark or scar on the bark. Such marks are usually met with in colonies of these and other Diaspinæ, etc., and to me are sure indications that the scales which originally covered them had been removed by birds.

Chionaspis salicis.—Common to the willow and ash, and sparingly met with on other trees. In summer the female puparium is conspicuous for its whiteness (Pl. D, fig. 1 A), but as winter approaches it darkens, until eventually it resembles very closely both the colour and texture of the bark of its food-plant. This is particularly noticeable on the ash, before the colonies become overcrowded. It not unfrequently happens, however, that the sombre-coloured scales of the females are completely hidden beneath the hordes of conspicuous white scales of the males (Pl. D, fig. 1 B). In winter these latter are empty, and might reasonably be supposed to afford the female scales a certain amount of protection, but I do not find this to be so. Everywhere the tits find out the female "scales," and devour them together with the females and eggs. One frequently finds the large colonies of these insects reduced to comparatively small numbers; indeed, so extensively are they attacked that it is exceptional to find a colony untouched by the birds. In Cheshire I have frequently observed the marsh titmouse (*Parus palustris*) feeding upon this Coccid, and I have little hesitation in saying that other members of the family do the same. One other feature worthy of comment is that the more a colony of this and the preceding species is robbed by birds the more conspicuous does the site become, owing to the mass of white scars left behind, and these latter may attract the little feathered migrants as they pass from place to place in search for food.

Asterodiaspis quercicola (Pl. D, fig. 2) is a curious little insect, making for itself those characteristic circular depressions in the young shoots of the oak. It is a common species, widely distributed, and in some localities occurs on every oak tree. In summer, when it is young, the delicate green colour of its test beautifully harmonises with the young green shoots, and it is hard to find. But in winter it may be more easily discovered as a minute shining speck in a shallow depression. From the post-mortem examinations we see it enters into the winter dietary of the long-tailed and blue tits, and I believe that other members of the Paridæ also feed upon this Coccid in the winter months, as it is often possible to find quite 90 per cent. of the depressions made by these insects untenanted. The searching eyes of the tits seem to find them out everywhere, and only a small percentage of them escape from their ceaseless search.

Lecanium, sp.?—The specimens found in the stomach of the jackdaw were of the *fuscum* type, and were fully grown adults at the period of gestation; and, judging from the locality from which the birds came, it is highly probable they had been taken from the adjacent branches of the tree in which the birds had nested. I am confident also that the house sparrow (*Passer domesticus*) will sometimes take these insects.

The first instance which came under my observation was with a large colony of *Lecanium generense*, ♀ (Pl. E, fig. 1), which infested a hawthorn hedge, and of which I had daily been watching the development. One day in May, when the insects were almost mature, I found, by the white scars which were left behind on the bark, that numbers of them had been removed from the branches; and on carefully watching the colony I found it was the work of a flock of sparrows. Whether they actually ate the Coccids, or whether they merely dislodged them, it is impossible to say, as I was unable to procure the birds for post-mortem examination, and the thick foliage pre-

vented closer observations. I have also observed in other localities that numbers of the same species of Coccid had been removed from branches of hawthorn in hedges, and I believe it to have been the work of birds, but of what species I am unable to say. The majority of the species of *Lecanium* pass the winter in a very young stage, and are small and hard to detect upon the branches. Possibly they may then be eaten by birds. In May the females become large, brightly coloured, conspicuous insects, and when bruised give off a somewhat disagreeable odour. I am inclined to think, therefore, that they are not so extensively fed upon by birds as the immature ♀ or the various species of Diaspinæ.

Pulvinaria ribesiæ (Pl. E, fig. 2).—On the morning of November 20th, 1900, I had a delightful opportunity of watching a marsh tit make an early meal off a colony of this Coccid which I had established on a *Ribes sanguineum* near to my house. The plant in question was quite close to a window, through which I could plainly see the bird peck off the insects. And when I thought the bird had taken as many of the Coccids as I could well afford, I drove it away. From the scars on the branches I was able to count the number of insects the bird had taken, which numbered twenty-seven. I have not seen another species of tit in my garden since, which is nothing unusual, as I am near the town, and have no trees to encourage them. But sparrows perch daily upon the branches of the same *Ribes*, and never take them. The Coccid in question was in its winter stage, measuring about 3 mm. long, and so closely does the colour of the insect harmonise with the bark that nothing could, I think, detect it at a distance of a few feet. I should add that the immature *Pulvinaria* are not distinguishable from the immature species of the preceding genus, which rather strengthens what I have there stated in reference to the young of the species of *Lecanium*.

I cannot imagine a bird feeding upon an adult female

Pulvinaria, or the eggs contained in its conspicuous white ovisac, as on the slightest touch the latter would adhere to the bird's beak and draw out into long sticky webs, and be with difficulty removed from its beak.

Referring again to the offensive odour which many of the Coccidæ possess, I may add that this is particularly noticeable in certain genera. Anyone who has crushed batches of "mealy bug" (*Dactylopius*, sp.) knows the odour is most disagreeable, and sometimes sufficient to permeate the whole cubic area of a hothouse of any ordinary dimensions. Birds sometimes gain access to our conservatories where "mealy bug" is often only too plentiful; indeed, I have seen the redbreast (*Erithacus rubecula*, Linn.) nest in such places, but I have never known it to eat the "bug" or "scale." With the possibly nauseous mealy bugs I would also include the genus *Pseudococcus* (Pl. C, fig. 1), *Cryptococcus fagi* (Pl. A, fig. 2), and *Apterococcus fraxini* (Pl. C, fig. 2), which are conspicuously white from the mealy or waxy coverings which protect their bodies. *Cryptococcus* and *Apterococcus* are very common insects, but in districts where they abound I have never seen birds feeding upon them; nor in winter could I ever trace any ruptured ovisacs, which would be sure to occur if birds fed to any degree on these insects.

I hope the importance of what has been set forth in the preceding pages with regard to the birds will not only appeal to the biologist, but also to the horticulturist, as I am confident their usefulness in checking such destructive species of Coccidæ as the "mussel scale" (*M. pomorum*), the willow and ash scale (*C. salicis*), which latter sometimes renders the "osiers" (*Salix*, sp.) too brittle for weaving purposes, is not to be overrated. Proof such as has been given is indisputable, and I am convinced that quite 50 per cent. of these insects are devoured by the birds whose names have been appended.

Micro-Fungi.

In this country micro-fungi are only occasionally destructive to Coccids, and so far as my experience goes only infest those species found on plants under glass. At the Royal Botanic Gardens, Kew, a colony of *Aspidiotus*, sp., was completely destroyed by a fungoid disease; and I have frequently seen colonies of *Lecanium*, spp., reduced by the same disease. The mycelium may be found traversing every part of the insect's body, but in no case have I found it penetrating into the tissues of the plants.

True it is that one invariably finds the old dead "scale" of our indigenous species attacked by mould, but this is the result of natural decay after death. I have not met with a single instance of an outdoor Coccid in this country being attacked by fungoid disease. But future research may prove they are not immune from such attacks.

Collecting and Preserving Coccidæ.

Unfortunately the Coccidæ do not appeal to us for their beauty, and owing to the lengthy and somewhat tedious process necessary for the microscopical study of them it is feared they will find comparatively few admirers. But from their economic importance many of them rank foremost amongst the most injurious insects of the world; and they certainly possess many characters of great interest to the biologist. It is hoped therefore that a few hints on collecting and preserving these insects may induce others to study them.

For field work the following apparatus is recommended:—strong pocket knife, small pair of pruning shears, botanist's vasculum, set of glass tubes in case, corked zinc collecting box, such as is used by lepi-

dopterists, envelopes, rubber bands, pins, shallow cardboard boxes, pencil, and a Coddington or other good pocket lens.

With such an outfit as the foregoing the collector may consider himself well equipped. One could do with less; but for a serious day's collecting all the articles enumerated will be found indispensable. The pocket knife will be needed for removing strips of bark; and the pruning shears, which may be attached to the buttonhole of one's coat, will be found a capital tool for removing small branches without damaging or jerking off the insects, which frequently happens when the knife is used. The tubes will be found useful for storing delicate and rare examples of the male scales (puparia), etc. As large quantities of specimens are generally required, the food-plant should be cut into suitable lengths, placed in an envelope or cardboard box, secured with a rubber band, and transferred to the vasculum. The corked zinc box will be found indispensable for pinning down slips of bark, etc., having specimens with delicate ovisacs attached. Unless the collector happens to be a good botanist, a leaf, flower, or fruit, or if small the whole plant, should be brought away for identification, as it is most essential the name of the food-plant should in all cases be identified and recorded. On reaching home the specimens should be removed at once from the glass tubes and metal cases, or in a very short time they will become mouldy and utterly unfit for study or preservation.

The trees most productive of scale insects are those growing in open spaces, and on the outskirts of woods and forests; parks and meadows; sheltered hedgerows, etc.; grass on hill-sides, moors, and sunny spots along hedgerows. The wood-rush (*Luzula campestris*) in warm damp situations harbours *Signoretia luzulæ*. The three indigenous species of *Orthezia* are found amongst moss, or at the roots of heather (Ericaceæ), on moors and in woods. The subterranean species should be looked for among grass roots in warm dry

situations; and roots of any kind penetrating into ants' nests should be carefully overhauled. See also p. 1, *et seq.*

The rearing of the male Coccid is by no means a difficult task, providing the scales (*puparia*) are removed with the food-plant after pupation has taken place, and when the insect no longer requires nourishment from the plant. This can generally be ascertained in the field with the aid of a good pocket lens. Should it be found necessary to remove the scale prematurely the perfect insects may sometimes be reared by placing the ends of the food-plant in a vessel of water. In all cases, after final pupation, the twigs, etc., bearing the scales should always be transferred to glass-topped boxes, and if moisture accumulates on the glass it should be removed, otherwise the wings of the insects will become entangled in it and destroyed. As a preventative never expose the boxes to the sun. Larvæ and parasites may be obtained in the same way as the males, but with much less difficulty. The females may be kept alive for several weeks by placing the ends of the food-plant in water. But by far the better plan to observe these insects through their various stages is to establish colonies of them on trees and plants at home. For any one who possesses a garden the plan is very simple. All that is required is a small collection of young forest trees, about four feet high, planted a few feet apart in a sheltered situation. To establish a colony of the insects, procure a number of scales or gravid females containing eggs, and tie the branches containing them to the growing plants. On hatching the larvæ at once fix themselves upon the growing plant, and there is no further trouble, except that in winter the birds may carry them off, but a piece of fish-netting thrown over the trees entirely prevents disappointments of this kind.

The preparation and preservation of the Coccidæ may be considered under two heads, viz. a dried collection suitable for exhibition in a museum, and a

collection prepared for microscopical study. The student will require both.

On looking over the entomological collections in our museums, I have been particularly struck with the almost entire absence of any species of Coccidæ. Here and there one sees odd specimens of *Coccus cacti*, the cochineal of commerce; and more rarely *Tachardia* (*Carteria*) *lacca*, the species which furnishes us with the all-important "lac" of commerce. Both are excellent examples in their way, but why not exhibit the British species? Anyone desirous of obtaining specimens could not do better than make his wants known to the gardeners of his particular district; for such men know to their cost what "scale insects" and "mealy bugs" are, and will gladly supply specimens when they find some interest is taken in the matter. Such, at any rate, has been my experience. Entomologists, too, when searching for galls or Coleoptera, etc., often make good finds, and many interesting species may be obtained through them. In short, express a desire for specimens, and all the commoner species will come to hand.

In all cases, or as far as practicable, the insects should remain *in situ* on the food-plant, whether bark, leaf, twig, or root. All superfluous parts, however, should be cut away, and only such portion or portions retained as may be needful. This if possible should be done while the food-plant is fresh, and the leaves will need to be fastened down with small card braces to prevent them curling up. The insects often cover the small branches of trees, and when such is the case they may be removed with the bark, or the branch may be divided longitudinally with a saw or split with a knife. The ends of all the pieces of hard wood will need to be pierced with a sharp penknife or very fine bradawl, so that they may be easily pinned in the cabinet. Set them aside to dry, away from the dust, and in a few days they will be ready for the cabinet. The simplest plan of finally mounting the specimens in the cabinet

is the one universally adopted, and consists of merely pinning the specimens in the cabinet in the ordinary way with a reference number, and a record label attached giving full particulars as to locality, date, and name of food-plant, and collector's name. To me such a system is anything but satisfactory; a collection thus arranged presents a very untidy appearance, and the removal of specimens for microscopical study is only too frequently attended with loss.

After many trials, the system which I have finally adopted for the display of my specimens is as follows. Lay in a stock of cork slips made from ordinary cabinet cork; size 3 in. × 1 in., which is the size of an ordinary slip used for microscopical purposes. Care, however, must be taken to have them of uniform size throughout, or the result will be anything but pleasing. The next process is to paper them. Take one of the cork slips, and with a small quantity of fish glue on a "dip stick," put a very narrow band of it all round the edge of the slip. Having done this, lay the slip, gummed side downwards, on the sheet of paper which has been selected to cover it, and press it firmly all round the edge. Do a number of slips in this way, laying them side by side, leaving a space of half an inch between each of them. When the sheet of paper has been filled with them, set them aside for a few minutes under light pressure, and afterwards separate them with a sharp penknife; finally trim off the paper from the edges of the cork slip with a pair of scissors. You then have a cork microscopical slip ready for the reception of the specimens at any time. When required for use attach a gummed microscopical label at one or both ends, and in the available space left pin or gum on the specimens. The best pins for the purpose are those known as "Lills," which can be purchased from any draper or silk mercer at 2s. 6d. per dozen sheets. Gum, however, should only be used in extreme cases. After fixing the specimens the pins should be cut down to mere stumps, otherwise their

numerous bright heads will appear more conspicuous than the insects. In all cases the food-plant only should be pinned; and it is often necessary to use small braces of thick black paper to hold leaves in position. The labels will afford ample space for full data, etc. For all species having white ovisacs or puparia black paper should be used, and for dark species white paper. Dull black "surface paper" and stout unglazed note-paper are the best, and if the instructions given in gumming be carried out the paper will not buckle. On the other hand, if the whole surface of the cork slip be gummed, the paper will buckle immediately, and present an untidy appearance. When it is necessary to show a larger series of any species than the limited space on a single slip will contain, a second slip will be required. This, however, need not be labelled, so that the whole of the slip may be utilised; care, however, should be taken to have the reference number attached.

Having completed the mounting of the specimens, all that is necessary is to fix them in their natural order in the cabinet drawers, which can be readily done with a pin at either end of the slip.

For my own part I prefer the slips mounted in rectangular glass-topped boxes, as they present a much neater appearance, and, what is more important, they can be easily removed from the cabinet and examined with a pocket lens without the least fear of damage to the specimens. The advantages claimed for such an arrangement are therefore obvious. The sizes of the rectangular glass-topped boxes are $3\frac{1}{2}$ inches by $2\frac{1}{2}$ inches, and 5 inches by $3\frac{1}{2}$ inches.

In order to bring the specimens as near the glass as possible a strip of cork should be glued to the ends of the boxes on the inside; on these the slips, which can be firmly attached with a pin at one or both ends, will rest. By this arrangement the specimens are brought nearer to the glass, and can be easily examined with a lens without the removal of the lid. Duplicates may be conveniently stored in shallow boxes or envelopes.

As the external characters presented by the puparia of many species are identical; the student will find it necessary at all times to examine microscopically the minute structural characters of the insects. To enable one to do this the insects must be treated with various reagents and permanently mounted. The materials required are—

1. Ten per cent. solution of caustic potash (KOH).
2. Distilled water.
3. Absolute alcohol.
4. Stain; for this I prefer "Crawshaw's magenta," which is sold in small packets.
5. Oil of cloves.

To prepare the Diaspinæ scrape off a quantity of the puparia (scales) into a sheet of white paper, and either place the whole of this, or better still select from the *débris*, the desiccated bodies of the insects; place them in a *small* tube, fill it up with the caustic potash, and plug with cotton wool. Place the tube with the specimens inside a test-tube and half fill with the caustic potash. Label the specimen (using a lead pencil), and either set aside in a test-tube stand or at once place it in a hot water bath. If necessary several species may be treated at the same time. Larger insects, such as *Lecanium*, *Dactylopius*, etc., may be placed in a test-tube. Boil the tube or tubes in a hot water bath until the insects are more or less transparent, which takes from one to twenty minutes according to the opacity of the insects, or rather the solubility of the body fats. With the larger specimens it is advisable to prick them with a needle in order to liberate the fats, etc., and subsequently shake them in a test-tube of water. In all cases thoroughly wash in two lots of distilled water, and afterwards—

(*a*) Transfer to equal parts of alcohol and water;
(*b*) To absolute alcohol for a few seconds;
(*c*) Stain with magenta stain dissolved in alcohol;
(*d*) Wash in alcohol;

(*e*) Soak in oil of cloves until all trace of air has disappeared, and finally mount in Canada balsam in xylol.

Should the oil not penetrate the specimens, gently heat it, together with the specimens, over a spirit lamp. The specimens will readily clear by this process, and it entirely prevents fogged mounts.

Should air-bubbles occur in the specimen after mounting in Canada balsam, place the mount over the gentle heat of a spirit lamp. It is advisable, however, not to apply heat except in extreme cases, as it destroys the stain, and sometimes shrivels the delicate parts of the insect.

The foregoing will serve equally well for all stages of the insects; but for fresh examples of the males, soaking in cold potash will sometimes give better results. Staining brings out the minute detail in a way that nothing else can; and I must here acknowledge my indebtedness to my friend and co-worker Mr. E. E. Green, of Ceylon, for the discovery of such an excellent staining medium as Crawshaw's magenta; without its aid it is well-nigh impossible to trace the minute but all-important structural details. The density of the stain may be regulated in the final washing of the alcohol.

There is yet another method of preparing the Coccidæ for museums, and this by making up life-history cases of injurious, beneficial, and mimetic species. Of the first we have at least four indigenous species injurious to fruit crops, viz. *Aspidiotus ostreæformis*, Curtis; *Mytilaspis pomorum*, Bouché; *Pulvinaria ribesiæ*, Signoret; and *Lecanium coryli*, Linn. And there are only too many species injurious to our stove and greenhouse plants which could be worked out in the same way. The beneficial species of importance are *Coccus cacti*, Linn.; *Tachardia* (*Carteria*) *lacca*, Kerr; and *Ericerus Pe-la*, West. It may be well to add that at the Liverpool Museum there are very interesting life-history cases of the two former species mounted together with personal ornaments, etc., made

from the natural products of these insects. Such exhibits are highly educational, and so also are the life-histories of the injurious species.

As to the mimetic species, I may mention the extraordinary *Physokermes abietis*, Geoffroy. The female of this species locates itself behind the old bud-scales of the spruce fir, and so exactly resembles the unopened bud of the tree that it is difficult at first to detect it.

Mould is the greatest enemy to the specimens, especially to those having delicate waxen coverings or ovisacs, which when once infested are utterly useless as museum specimens, as they can never be restored. The best preventive against mould is the free use of carbolic acid in the cabinet drawers or boxes, as the case may be. Mould is generally set up by an excess of moisture. In my own collections this has been undoubtedly due to the gum used for mounting the specimens, or from portions of the food-plant which had not been thoroughly dried before placing them in the cabinet. By adding a few drops of carbolic acid to the gum, and by thoroughly drying the specimens, mould may be prevented, providing always the specimens are housed in a dry place. "Mites" (Psocidæ) simply revel among stored specimens of the Coccidæ, but the free use of naphthaline of the form known as albo-carbon is a perfect preventive.

Methods of Prevention and Remedies.

As Coccids subsist upon the sap or juice of the plant which they attack, by sucking it up with their rostrum from the *interior* of the leaf or twig, it is obvious that any application made for their destruction must necessarily be such as will kill them by affecting the respiratory organs, such as hydrocyanic gas; or by direct contact with their bodies, such as washes and emulsions. Paris green, or any such mineral poison which

has to be taken into the body before it becomes effective, is of no use against "scale" and "mealy bug," or aphides, or any insect which lives by suction.

In this country there is no organised system of prevention against the introduction of insect pests, which, to say the least of it, is a very unsatisfactory state of affairs, resulting only too frequently in the introduction of new Coccids from all quarters of the globe. As instances of such introduction I may mention the following species, which, with two exceptions, have thoroughly established themselves in this country:

Aspidiotus alienus, Newstead. Discovered in 1889 by Mr. E. E. Green.

Diaspis (*Aulacaspis*) *pentagona*, Targ.-Tozz. Imported from Japan in 1898.

Mytilaspis citricola, Packard. Common on imported oranges and lemons, and quite recently on cultivated plants.

Ischnaspis filiformis, Douglas. Discovered in 1887, when Mr. Douglas first described it. It occurs now in many places as a greenhouse pest.

Gymnaspis æchmeæ, Newstead. Quite a recent introduction. It is now well established and increasing.

Fiorinia fioriniæ, Targioni-Tozzetti. A pest on palms in many districts.

F. Kewensis, Newstead. Quite recently discovered.

Pinnaspis pandani, Comstock. Chiefly a palm pest, and very destructive.

Orthesia insignis, Douglas. Steadily increasing, and extending into fresh districts.

Icerya ægyptiacum, Douglas. The plants upon which this species was imported were all destroyed, and no trace of the insects have since been found.

Thus within the last twelve years we have seen the introduction of at least ten species of Coccids, of which *Orthesia insignis* may prove as injurious to our cultivated plants as our common "mealy bugs" (*Dactylopius*, spp.), and it is much more difficult to destroy than the latter. It needs, therefore, no further com-

ment of mine to show how important it is we should take every precaution to guard ourselves against such introductions, by careful investigation and treatment of imported plants immediately on arrival in this country. Seeing that we have no recognised system of dealing with wholesale consignments of infested plants, it may be well to consider how such work is carried out in other countries. In his admirable work on the Coccidæ of Ceylon, Mr. E. E. Green enters fully into the subject, describing the treatment as adopted by himself, from information supplied by Mr. C. P. Lounsbury, Official Entomologist at Cape Town. As I do not possess Mr. Lounsbury's official work, I have taken the liberty of extracting from Mr. Green, who says, "For wholesale fumigation of plants and fruits there is nothing to equal hydrocyanic acid gas, generated by mixing cyanide of potassium, water, and sulphuric acid in certain proportions. This treatment is cheap and effectual. The gas is of the most deadly nature, and will penetrate every crack and crevice, and do its work thoroughly. The application is quite simple. All that is required is a close-fitting chamber, provided with a flue for the escape of the gas after the operation. The more airtight the chamber the more complete will be the work. It should be fitted with racks to receive moveable trays, upon which fruit may be spread. The objects to be fumigated are placed into position; the chemicals are mixed in a leaden or earthenware pan and placed on the floor, the door shut, and the room kept closed for from half to three quarters of an hour. The flue is then opened, and after a sufficient time (about half an hour) has been allowed for ventilation the door is unlocked, and the plants, etc., removed. It is not advisable to take the subjected plants directly into the open air if the sun is shining. They should be kept for a few hours under shade, which will greatly lessen any danger of damage.

"Mr. C. P. Lounsbury, Official Entomologist at Cape Town, has kindly supplied me with full particulars of

the work of the fumigatorium at that place. From his letters and reports I have extracted the following directions and suggestions:—'For each 300 cubic feet of space enclosed (and in proportion for greater and smaller spaces) one ounce of 98 per cent. potassium cyanide, one ounce of sulphuric acid, and two ounces of water will be required to generate gas of sufficient strength to kill the insects. Double this strength, or the same amount of materials to 150 cubic feet enclosed, may be used upon woody plants without danger of seriously injuring them. The greater strength should be employed whenever practicable, as it will ensure the death of the eggs as well as the active insects.'

"Imported plants are usually in a more or less dormant condition, which lessens danger of injury. Mr. Lounsbury writes, in his report of June, 1897, 'Injury to the tips of new growth generally results. This injury is in no wise serious, and is quickly outgrown. The operators consider it a favourable indication, as when such injury results it is quite certain that the gas has been present in sufficient strength to destroy all of the insects.'

"With respect to fruit, I again quote from Mr. Lounsbury's letter:—'I had had lemons and oranges analysed after treatment, and found that after a few hours not more than a trace of the gas remained in the rind. There is much more natural cyanogen in a single seed (so the analyst told me) than what remains in the fruit from fumigation. We have no complaints of any effect on the keeping qualities of the fruit.'

"To generate the gas the required quantities of cyanide and water are first placed in the generating vessel, the cyanide being broken into small pieces about the size of lump sugar. The operator then adds the acid, pouring it slowly into the vessel to avoid splashing, and immediately withdraws.

"The above treatment is suitable for fruit and hardy plants. Tender garden plants are usually imported in

Wardian cases, and may be treated separately. We have—in the 'Wardian case'—an airtight chamber ready to hand, in which the plants can be fumigated before their removal. After a large series of experiments with various fumigating media, I find that hydrocyanic acid gas remains by far the most efficient insecticide, and the least injurious to the plants. But with delicate succulent plants I find it has to be applied rather differently. A more concentrated dose of the gas applied for a shorter period is most satisfactory in its results. In a Wardian case containing about sixteen cubic feet I find a dose of half an ounce cyanide, half an ounce acid, and one ounce water, with an exposure of half an hour, will kill every individual of a colony of Orthezia (the most resistent of all Coccids) without in the least affecting the plants. The treatment should be carried out only after sunset. According to Mr. Lounsbury's tables, these proportions of chemicals should be sufficient for a space of 140 cubic feet with a longer exposure."

Mr. Green further describes the treatment of orchard trees on a large scale, quoting again from Mr. Lounsbury's method.

"*Generation of the Gas.*—Hydrocyanic acid gas is generated by the action of sulphuric acid on potassium cyanide in the presence of water. The required quantities of the cyanide and water are first placed in the generating vessel, the cyanide being broken into small pieces not above the size of lump sugar. The tree is then covered with the tent or sheet, and the vessel slipped under almost to the base of the tree. Reaching in, the operator then adds the acid, pouring it slowly into the vessel so as to avoid its splashing, and thus burning his hand or the cloth. He immediately withdraws, and the men shovel a little soil on the edges of the cloth all around, to more thoroughly prevent the escape of the gas.

"The rapidity of the evolution of the gas depends largely upon the size of the pieces of cyanide. If

these are like powder the reaction is violent and immediate, but if in lumps the reaction takes place more slowly, and continues for a minute or longer. The slow reaction is desired partly because less injury results to the foliage immediately above the vessel. But the lumps must not be too large, for then the reaction is liable to be imperfect, owing to a black coating (carbon ?) forming over the lumps, and preventing further decomposition by the acid. The water should not be added too soon, or part of the cyanide becomes dissolved, and gives a violent reaction. The residue which remains in the dishes is buried, and the dishes are washed in clean water before being again used.

"*Time necessary for Treatment.*—The cover is left over the tree for thirty minutes in the case of small trees, and forty-five in the case of those over twelve feet in height. At the expiration of this period the generating vessel is removed, and the residue buried in the soil.

"A number of trees are fumigated together, the endeavour being to treat as many at a time as can be covered and uncovered during the period of exposure. In this way the men are kept continuously busy, the time for the removal of the first tent arriving by the time that the last tree is covered.

"*Absence of Sunlight necessary.*—The originators of the fumigation process observed that the gas was most efficacious, and that less injury resulted to the foliage when the operations were performed at night than when they were carried on in sunlight. It is said that chemical changes are produced in the gas by the action of sunlight, and that the resulting gases are more injurious to the plant life and less to animal than hydrocyanic acid gas. Whether or not these theories are correct is of small practical importance, for the foliage of a tree will suffer serious injury if the tree is left covered with an airtight oiled tent for half an hour in sunlight without the gas being present. Having

ascertained this fact by experience, the foreman in charge of the Board's outfit refrained from covering trees until the sun had sunk from sight on any but cool dull days. The great majority of the trees treated have been fumigated after sunset. The ideal night for fumigating is quiet, cool, and moonlight, and without dew."

From such valuable and trustworthy evidence as the foregoing we may safely take action with consignments of hard-wooded plants. But for such tender things as orchids or other rare and costly plants the process is likely to end in serious injury to them, and cannot therefore be expected to find *universal* favour amongst English horticulturists.* There is this to be added, however, that all other fumigating compounds have been found by Mr. Green less effectual to Coccids and more injurious to plant life than the hydrocyanic acid gas.

In the absence of fumigation or of the application of insecticides, which, owing to the nature and condition of the plant, may be deemed inadvisable, a thorough sponging with clean water should invariably be made. All foreign substances should be removed, and the plant or plants afterwards watched for any signs of the development of scale or bug.

Coccids are also freely imported into this country on oranges and lemons, including the troublesome and

* In the Journal of the South-Eastern Agricultural College, Wye, Kent, No. 9, April, 1900, Mr. H. H. Cousins gives a report on some excellent results obtained by fumigation of vines and greenhouse plants with hydrocyanic acid. For mealy bug he recommends "3½ oz. cyanide, 5 oz. acid, 8 oz. water per 1000 cubic feet, either before the vines bloom, or when grapes are colouring, or after the crop has been gathered. At either of these stages no harm results to either foliage or fruit. Avoid fumigation when the vines are in bloom or before the grapes have commenced to ripen," (l. c., p. 70).

"For ordinary greenhouse pests, such as aphis, dolphin, white-fly, slugs, woodlice, red spider, and caterpillars, a dose not exceeding 1¾ to 2 oz. cyanide, 4 oz. acid, 7 oz. water per 1000 cubic feet has proved itself satisfactory," (l. c., p. 70). In one greenhouse in which the experiment was conducted there were chrysanthemums in full bloom. Mr. Cousins says "not a petal or leaf was injured."

destructive *Aspidiotus aurantii*, etc. Care should, therefore, be taken not to place infested fruit near to growing plants; and the rinds of all infested fruit should be destroyed.

The encouragement of the various species of tits (Paridæ), the tree creeper, and other insectivorous birds in our gardens is also a sure means of checking the increase of certain Coccids, and their presence in our gardens during winter should never be denied. Their services at such times cannot be overrated, and more especially so that of the little blue titmouse. I am fully aware of the injury caused by these birds to apples and pears; but in view of their excellent services give them all the encouragement you can afford. In winter encourage their presence by throwing out an occasional handful of maize; this will attract them, and will generally keep them within the bounds of your garden. When they have finished the food which has been given them, which should not be too plentiful, they will fill in the hours by incessantly searching for insects, and where "mussel scale" abounds they freely eat it. (See also chapter on Natural Enemies of the Coccidæ, pp. 33—41.)

Insecticides.

Paraffin and Soap, or "Kerosene Emulsion."—This is one of the most effective of insecticides, and may be used as a remedy against various insect pests. Under varying proportions of the ingredients it has been in use for a number of years, and has found much favour among horticulturists. The only difficulty with this preparation is to obtain a perfect emulsion, which for obvious reasons must be made; and to ensure this use the following proportions:

Soap	½ lb.
Paraffin	2 galls.
Soft water	1 gall.

Boil the soap in the water, and when thoroughly dissolved and still hot add the paraffin and churn with a syringe until a white creamy mixture has been obtained. If the instructions are properly carried out the ingredients will not separate. The mixture may be set aside for future use in corked bottles, or, as I prefer, used at once. For bark applications add to this nine times the quantity of hot soft water, and again churn with a syringe until the ingredients have again amalgamated.

The application should be made in the winter months with a stiff brush, taking care to rub it well into the old rough bark, and to thoroughly soak any shreds which may of necessity have to be left as supports to the branches of wall trees. Some prefer to use the mixture while hot, say at a temperature of 130° F., but for outdoor work I have found it quite impossible to maintain any given temperature. The secret of success lies chiefly in a perfect emulsion, and thorough application of it.

From recent experiments conducted in a large peach-house, I find this the most effectual remedy for the brown peach scale (*Lecanium persicæ*), killing about 80 per cent. of the larvæ.

This emulsion may also be used for spraying foliage for other as well as scale insects. For tender plants, and unripe wood and foliage, about double the quantity of water should be added; but even then the mixture is apt to scorch. It is advisable, therefore, to test the effect of the emulsion on the foliage before making wholesale applications of it, as it may be found necessary to considerably weaken it by the application of water. It should be borne in mind that a certain percentage of soap, paraffin, and water is more deadly in its effects upon plants than pure paraffin—a fact abundantly proved in the experiments conducted at Woburn on the currant *Phytoptus*. And what is more, certain plants can withstand the application more than others, and it will be necessary to vary the strength of the emulsion to suit them.

Whale oil and hard white laundry soap has been recommended for use in the preparation of this insecticide; but as soft soap finds greatest favour among English horticulturists, I see no valid reason why it should not be used. It mixes thoroughly well with paraffin, and does not solidify.

Smith's "Swift and Sure."—This is a very effective insecticide for soft-bodied and unprotected "scale" and "mealy bug," but its effect upon the small shield-covered scales (*Diaspinæ*) is of very little service. For hard-wooded plants without leaves it has been found most effectual when applied at a temperature of from 130° to 140° F., and for plants with leaves heated to not more than 100° F.

"*Fir-tree Oil.*"—An old and well-tried remedy; but, like paraffin, is apt to "scorch" or burn the foliage if applied in bright sunlight. If applied to foliage, the plants should receive a good syringing the day after its application. But this need not be done when the application has been made on plants or trees without leaves.

Soft Soap.—For "sponging" greenhouse plants this is a most efficacious remedy. For this purpose it is used in varying strengths of from 1 to 3 oz. per gallon of water; the weaker solution should be used for such tender plants as *Eucharis*, etc. For *bark* application *only* it may be used at a strength of 8 oz. to the gallon of water. For "mussel scale" infesting the trunk and main branches of apple and pear, as also for *Crypto-coccus fagi* infesting beech trunks it has proved a complete success. In all cases it is best to dissolve the soap by boiling it in a quart of water, afterwards adding the full quantity.

"*Gishurst's Compound.*"—This is an excellent compound, and for "sponging" plants I have never found it excelled. I have also found it the best remedy for "buggy" vines. But, like other patent insecticides, it is much too costly to use on a large scale.

Lime Wash, or Lime Water.—This should be made of good fresh lime. I have twice seen this applied to

peach and nectarine for destroying the "brown scale" (*Lecanium persicæ*). In both instances less than fifty per cent. of the insects were destroyed. In applying this to the trees the operator should wear gloves, as the caustic properties of the lime burn the hands terribly.

Caustic Soda Wash.—This consists of the following ingredients:

1 lb. ground caustic soda.
¾ lb. pearlash.
10 oz. soft soap.
10 gallons of water.

Apply at a temperature of 130° Fahr.

This has been frequently recommended for dressing peach and other trees infested with scale. Having personally witnessed both the mixing and application of this mixture, I can speak with certainty as to its effect upon the "brown peach scale." In the winter of 1899 this mixture was applied to a number of peach trees (under glass) with an ordinary paint-brush. The result was fairly satisfactory, and, judging from the number of females which appeared in the spring, I should estimate that about sixty per cent. of the insects were killed. The application did certainly not appear to injure the trees; in fact, one of the largest and best crops of fruit was grown. Seeing the enormous percentage of various alkalies the preparation contains, it would certainly be unsafe to make an annual application of this mixture, as it must in time prove fatal to the health of the trees. Moreover it is a painful experience applying it, and for these reasons I certainly do not approve of its use, and more especially so as the paraffin emulsion is more effectual and comparatively pleasant to use.

"*Clay and Sulphur*," *or* "*Cow-dung and Sulphur*."—Such mixtures are absolutely useless against "scale insects," and clay or cow-dung in any form I have found most objectionable. I have so frequently seen them used against the "brown peach scale" that I am quite confident of the results obtained. And from

practical experience I cannot too strongly condemn their use against insects of any kind.

Methods of applying the Insecticides.

In this country the application of insecticides against Coccids is usually performed with a brush or sponge, which is the most effectual plan, as it gives decidedly the best results. But where a large quantity of trees and plants have to be dealt with, which is often the case, the application should be made with a spraying apparatus, or, as in the case of small plants, such as palms and crotons, etc., they can be expeditiously treated by dipping them in the mixture, care being taken to remove all the visible scale or bug with the fingers. The plants should then be carefully shaken and laid on their sides to drain. This process is frequently adopted by large growers of plants for table decoration,—such, for instance, as palms and crotons. I have seen the process carried out by a competent and experienced plant foreman, in whose hands the work was a complete success, the insecticide used being a weak form of the "kerosene emulsion," No. 1, but not exactly of the same proportions of soap and paraffin, the proportions used being as follows:

¼ pint paraffin.
½ lb. soft soap.
3 gallons soft water.

The method of mixing is also different, and is as follows:

Place the paraffin and soap together in a vessel, and with the hands or a stick very thoroughly mix them together until there is no liquid paraffin left; after which the bulk of water is added warm and churned with a syringe.

Sponging.—"Gishurst's Compound" or soft soap is generally used for this purpose, but the process can

only be carried out on comparatively large smooth-leaved plants, such as eucharis, crotons, palms, camellias, etc. It is a favourite and at the same time thorough method, and is very generally adopted by horticulturists.

Brush Application.—For all wall-trained trees, such as peaches, nectarines, apples, pears, etc., it is impossible to thoroughly apply a dressing by any other means than a brush. It is truly a laborious process, and entails a vast amount of time and patience, but with a good insecticide this method gives the most satisfaction. It is obvious the branches should be un-nailed, in order they may be painted all round, taking special care to get behind them (*i. e.* between the branches and the wall), as it is there the greatest number of scale accumulates. Where supporting "shreds" are of necessity left, these should receive careful attention.

Spraying.—When a large number of trees have to be treated, which fortunately is rarely the case in England, or, as in large conservatories, where tall palms, creepers, etc., are out of reach, the only chance of applying an insecticide is with a spraying apparatus, such as a "Stott" syringe or sprayer.

Dipping.—All that is necessary for this purpose is to provide a large wooden vessel or tub capable of holding from three to six gallons of the wash.

The whole plant, *minus the pot*, is then plunged into the mixture.

Both outdoor and greenhouse and conservatory work are best carried out in the winter months, when other work is slack, and while plants are more or less in a resting condition, and can better resist the action of an insecticide. But certain Coccids increase so rapidly in summer that plants require frequent attention, which must necessarily be given wherever there is available help. In spring or summer dull or cloudy days should be selected for treatment of plants. Application made in bright sunlight scorches and otherwise injures the foliage. Failing dull days, apply the insecticide in the evening, after the sun has lost its power or gone

down. And when tender plants have been treated, follow the application next day with a thorough syringing with cold water.

Unless you are thoroughly acquainted with the insecticide intended for use, test it upon a part of the infested plant or plants and watch the result.

Treatment for Root-feeding Species.

It is only quite recently that root-feeding Coccids have proved injurious to plant life in this country. In February, 1895, a minute species of mealy bug (*Ripersia terrestris*, Newstead) was discovered near London on roots of stephanotis.* The following year I also received the same species from Mr. C. O. Waterhouse (Brit. Museum Nat. Hist.) on palm roots, but from the comparatively few examples which attacked the plants in question I did not consider the species caused material injury to the plants. Quite recently, however, Mr. F. W. Burbidge called my attention to the species attacking the roots of warm greenhouse ferns in co. Kildare, Ireland, causing the foliage to turn brown and look as if the plants had been dried too much at the roots; and in specimens kindly supplied by Mr. F. Bedford I must admit the insects had caused considerable injury to the plants. I cannot, for obvious reasons, here describe the insect more than to say that it lives chiefly upon the terminal or outside roots of the pot plants, where it secretes or spins patches of pure white fibrous wax similar to that made by the common mealy bugs, but less compact. In these retreats the insects live and lay their eggs.

The origin of this pest remains to be discovered. In all probability it is an indigenous species, and may have been introduced in the potting material. But as the insect has not been met with outside it may have been introduced on the roots of imported plants.

* Entomologist's Mo. Mag., S.S., vol. vi, pp. 213, 214, figs. 1—5.

There is also another subterranean species (*Dactylopius radicum*, Newstead), which has been known to cause serious injury to the strawberry when cultivated in pots. In this instance, however, there could be no doubt that the insects were introduced in the fresh turf used in the cultivation of the plants. Externally this species very closely resembles the preceding, but is a trifle larger. In both species the white woolly retreats and ovisacs secreted among the roots of the food-plant bear a striking resemblance to the fine white mycelium commonly met with on grass roots in loamy soils, and, owing to the striking similarity, it is feared the insects get overlooked and passed off as "fungus spawn."

Treatment.—(1) Never, if possible, use the outside of turf-stacks or fresh turf for potting purposes.

(2) Do not turn the infested plants out of the pots while in the conservatory, as a strong current of air may sometimes carry away a patch of the woolly material, and with it the eggs or females.

(3) Infested plants should, at the proper season, have all soil removed from the roots and thoroughly washed in two lots of clean water. The pots from the infested plants should be immersed in scalding water or heated to destroy any adhering eggs or insects.

(4) To destroys the Coccids on growing plants remove the pot and thoroughly spray the exposed roots and soil with carbon bisulphide (CS_2) using a small glass spraying apparatus. Scald the pot and have it in readiness for replacing *immediately* after spraying. The eggs, unfortunately, are not destroyed by this process, and it will be found necessary to repeat the application. I have not found the carbon bisulphide injurious to maidenhair ferns while in active growth, providing always that the plants were kept in the shade for a week after spraying.

Characters and Classification.

The Coccidæ are a family of the sub-order Hemiptera-Homoptera, which includes also the Aleyrodidæ, Aphididæ, Psyllidæ, and Cicadæ. Certain of these families often bear a striking superficial resemblance to each other, which is especially noticeable in the immature or stationary conditions of the Aleyrodidæ; and among the Aphididæ, *Cerataphis lataniæ* is frequently mistaken for a Coccid, and is known among horticulturists as "the black seed scale." All the insects of the order are characterised by the possession of suctorial mouths, and, taken together with the Hemiptera-Heteroptera, constitute the whole of the sub-class Haustellata of the Insecta.

The characters by which the Coccidæ may be distinguished from the other allied families of the Homoptera are as follows:

Larva.

Larva minute, active. Male and female rarely separable, usually naked; tarsi as in the adults.

Female.

(1) Wings always absent.

(2) Head and thorax united, boundary line generally indicated.

(3) Tarsi generally monomerous with a single claw. (In the abnormal genus *Exæretopus*, Newstead, and the gall-making *Olliffiella*, Cockerell, the *anterior* tarsi are two-jointed.)

(4) Mouth or rostrum placed on the ventral surface, a little anterior to or behind the insertion of anterior pair of legs. (It is absent in the adult females of the exotic genus *Margarodes*.)

(5) Metamorphosis incomplete.

Male.

(1) Wings, when present, two; posterior pair represented by a pair of halteres, the bristles of which fit into a fold or pocket near the base of the wings.

(2) Segmentation between head and thorax usually distinct. (An exception occurs in the British *Apterococcus fraxini*, Newstead, where the boundary between the head, thorax, and abdomen is practically obsolete. The same abnormal character has also been met with in a species from New Zealand and elsewhere.)

(3) Legs with the tarsi as in the adult ♀.

(4) Mouth obsolete, one or more pairs of large ocelli usually occupying its position.

(5) Metamorphosis complete; mouth organs lost at period of pupation.

One of the surest marks of distinction lies in the monomerous tarsi and single claw, which, as a rule, will readily separate a Coccid from any of the closely allied families which may otherwise resemble it.

Both sexes secrete a varying quantity of waxy, mealy, horny, or resinous substance, which may be either attached to the body, as in *Dactylopius* and *Orthezia*; form a separate shield-like covering, as in the *Diaspinæ*; a complete fibrous or felted sac, as in *Eriococcus*, etc.; or a resinous cell, as in the foreign genus *Tachardia*. These secretionary coverings afford valuable data for the separation of the various sub-families and genera; and the sexual difference, both in form and nature of the secretion, is generally very pronounced.

Taking the family as a whole, both foreign and British, the division of the Coccidæ into sub-families has been variously set forth by most of the leading authorities. In this work I have, with slight alterations, adopted the very clear and comprehensive divi-

sions recently given by Mr. E. E. Green (Coccidæ of Ceylon, pp. 16, 17), adding thereto the subdivision *Margarodinæ*, which, from the absence of mouth-parts in the adult female, I agree with Professor Cockerell ("Tables for the Determination of the Genera of Coccidæ," Canad. Ent., vol. xxxi, pp. 273—279) naturally calls for a separate division. I should also add that Mr. Green places the *Conchaspinæ* before the *Diaspinæ*; but it seems to me, although I may be quite wrong, that the insects comprising this sub-family are more naturally placed in the ascending order above the *Diaspinæ*, and I have therefore made this additional deviation from Mr. Green's classification.

Synopsis of Sub-families.

A. *Males with Simple Eyes.*

a. Abdomen of female terminating in a compound segment forming a definite pygidium. Anal orifice simple.

(I) Insects with a separate covering scale (puparium), composed partly of moulted skins (exuviæ) and partly of secretion. Adult females without legs; antennæ rudimentary; mentum monomerous. DIASPINÆ.

(II) "Insects with a separate covering scale formed entirely of secretionary matter, without admixture of the exuviæ. Adult female retaining limbs and antennæ. Mentum dimerous" (Green, *l. c.*). CONCHASPINÆ.

b. Abdomen of female without definite pygidium. Anal orifice setiferous.

(III) Females with posterior extremity cleft; anal orifice closed by a pair of dorsal plates. Larvæ with prominent setiferous lobes within the anal cleft. LECANIINÆ.

(IV) "Adult females with cleft extremity and anal

plates as in *Lecanium*. Larvæ with abdominal lobes as in *Dactylopiinæ*" (Green, *l. c.*).

HEMICOCCINÆ.

(v) Abdominal extremity not cleft, usually with a pair of more or less prominent setiferous lobes at margin. Abdominal extremity of larvæ similar. DACTYLOPIINÆ.

c. "Insects enclosed in a resinous cell with three orifices. Adult female apodous, with the terminal segments produced into a tail-like organ bearing at the extremity the anal orifice, which is surrounded by a broken setiferous ring. A prominent spine-like organ above the base of the caudal extension" (Green, *l. c.*).

(VI) . . . . . *TACHARDIINÆ.

d. Females with anal tubercles obsolete or indicated by a single hair. Anal ring simple.

(VII) . . . . . COCCINÆ.

e. "Adult females active or stationary; gall-making, or naked, or producing cotton or wax. Anal tubercles entirely absent; anal ring hairless. Antennæ with usually less than seven joints. Body not prolonged posteriorly" (Maskell, Trans. New Zealand Inst., 1892, p. 236). "Larvæ with anal tubercles, adult without" (Green, *l. c.*).

(VIII) . . . . *IDIOCOCCINÆ.

f. "Insects enclosed in galls. Limbs either persisting, rudimentary, or obsolete" (Green, *l. c.*). End of abdomen much attenuated and tail-like.

(IX) . . . . *BRACHYSCELINÆ.

B. *Males with Compound Eyes.*

a. Females with setiferous anal orifice.

(X) . . . . . ORTHEZIINÆ.

b. Females without setiferous anal orifice.

(XI) Mouth-parts absent in adult females.

*MARGARODINÆ.

(XII) Mouth-parts present in adult females.

MONOPHLEBINÆ.

* Not at present represented in the British Isles.

DIASPINÆ.

Insects covering themselves with a dorsal and ventral shield or scale (puparium), composed partly of discarded skins and partly of secreted matter, or entirely of discarded skins (exuviæ). Females apodous after the first stage, have rudimentary antennæ and monomerous mentum.

PUPARIUM OF FEMALE.

This is formed by the three stages of the insect, viz. larva, second-stage female, and the adult. In the larval stage the dorsum usually becomes covered with secretionary matter, varying from a very delicate transparent film to an opaque nipple-shaped structure; and towards moulting period the upper parts of the derm become highly chitinised. Mr. Green* has ob-

FIG. 1. FIG. 2.

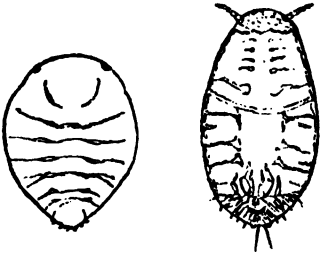

FIG. 1.—Larval exuviæ of *Aspidiotus*. × 30.
FIG. 2.—Larval exuviæ of *Mytilaspis*. × 30.

served a remarkable difference in the method of effecting the ecdysis between *Aspidiotus* and other genera. He says, "In *Aspidiotus* the larval skin splits along the margins, completely separating the dorsal and ventral halves, which subsequently become incorporated respectively into the dorsal and ventral scales of the puparium. In this case the visible part of the pellicle will be destitute of the sheaths of the antennæ

* Coccidæ of Ceylon, p. 24.

or limbs (Fig. 1). In all other genera that I have observed the whole of the larval skin is attached to the dorsal scale of the puparium, the rupture occurring on the under surface of the head at a point between the antennæ and the rostrum, the antennæ remaining attached to the anterior margin, while the rest of the ventral parts, with the limbs and rostral apparatus, are pushed back to the posterior extremity" (Fig. 2). After the change the apodous insect soon grows beyond the limits of the larval exuviæ, and, in order to protect its body, covers it with secretion, which is either formed

FIG. 3. FIG. 4.

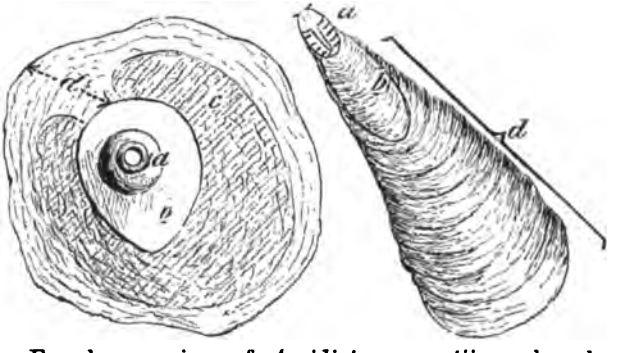

FIG. 3.—Female puparium of *Aspidiotus aurantii*: *a*, larval exuviæ hidden by opaque secretionary covering; *b*, second exuviæ; *c*, sublying female; *d*, secretionary portion.

FIG. 4.—Female puparium of *Chionaspis aspidistræ*: *a*, larval exuviæ; *b*, second exuviæ; *d*, secretionary portion.

in a circle round the larval exuviæ as in *Aspidiotus*, *Diaspis*, etc. (Fig. 3), or extended backwards as in *Chionaspis*, etc. (Fig. 4). Beneath this covering the second and final moult is effected, either by the whole of the ventral parts of the insect being pushed back to the posterior extremity, which together with the dorsal skin remains attached to the secretion, thus forming the second exuviæ or pellicle; or the moulted skin remains intact, and completely encloses the adult insect. In this latter case the cast skin, necessarily

very large, completes the formation of the puparium (Pl. XXIX, figs. 1, 2; Pl. XXXIV, figs. 1—6). But in *Aspidiotus* (Fig. 3), *Chionaspis* (Fig. 4), and other genera the adult insect grows considerably after the second moult, adding during the time a large secretionary covering.

Puparium of Male.

Characterised by possessing only the discarded skin (exuviæ) of the larva. It is usually begun in the same way as that of the female, but the subsequent and complete formation of the puparium is accomplished by the second-stage insect, and consists entirely of secreted matter. In *Aspidiotus* (Fig. 5) the secretionary portion is arranged in a more or less circular form,

Fig. 5.—Male puparium of *Aspidiotus* × 20: *a*, larval exuviæ hidden by opaque secretionary covering; *b*, secretionary portion.
Fig. 6.—Male puparium of *Chionaspis*, *Diaspis*, etc., × 20: *a*, larval exuviæ; *b*, secretionary portion.
Fig. 7.—Male puparium of *Mytilaspis* × 20: *a*, larval exuviæ; *b*, secretionary portion with hinge-like structure.

with the exuviæ central or subcentral. In *Chionaspis* (Fig. 6) and *Mytilaspis* (Fig. 7) it is extended backwards, and the larval exuviæ is terminal. In *Aspidiotus*, *Gymnaspis*, *Mytilaspis*, etc., it is of a coriaceous or horny substance; while in *Chionaspis*, *Diaspis*, and other genera it is white and of a felted nature (Fig. 6).

Ovum.

The eggs are laid within the puparium (Pl. XIV, fig. 3), and are of an elongate form, with the ends equally rounded, usually straight, but sometimes slightly curved (Pl. XIII, fig. 7).

Larva.

Active for a short period only. Form ovate or slightly elongate (Fig. 8, *Mytilaspis pomorum*). Antennæ normally of six joints (Fig. 9). The funiculate examples, which frequently occur, appear to consist of

Fig. 9. Fig. 8. Fig. 10.

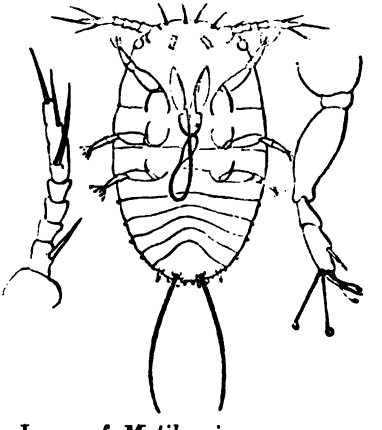

Fig. 8.—Larva of *Mytilaspis pomorum*, ventral.
Fig. 9.—Antenna of ditto.
Fig. 10.—Leg of ditto. All magnified.

only five joints (Pl. XVIII, fig. 7), but owing to the numerous transverse wrinkles in the long terminal joint it is impossible to trace an additional articulation.

The segmentation of the thoracic and six abdominal segments can be traced; the remaining segments, being fused together, form the pygidium, which bears

the anal opening, two caudal setæ, lobes, plates, and spines. Eyes distinct. The rostrum, comparatively large, resembles that of the female. Legs (Fig. 10) short, consisting of five parts; the monomerous tarsus is furnished with a simple claw and four knobbed hairs (digitules).

Second-stage Female.

(Pl. XXV, fig. 11; Pl. XXIX, fig. 8.)

Closely resembles the adult insect, but is not known to possess the grouped circumgenital glands. In the genus *Aonidia*, *Gymnaspis*, and *Fiorinia*, the insect attains its greatest dimensions in this stage, and its moulted skin, enclosing the adult insect, chiefly or entirely forms the puparium. In *Aspidiotus*, *Diaspis*, *Chionaspis*, etc., the moult takes place when the insect is very small, and the cast skin (exuviæ) forms but a small portion of the puparium.

Adult Female.

(Pl. I, figs. 3, 9, 10; Pl. IX, figs. 4, 5; Pl. XXI, figs. 9, 10, 11; Pl. XXV, figs. 1, 10; Pl. XXXII, figs. 1, 3, and elsewhere.)

Apodous, and with rudimentary antennæ, consisting of a minute tubercle and one or more stiff hairs.

The variation in the form of the insects may be best gathered from a study of the figures on the plates. The rostrum is placed on the ventral surface towards the anterior margin; it consists of three distinct parts: the basal portion, a large complicated chitinous structure, the second, the true mentum, a minute monomerous process to which is attached the long sucking apparatus consisting of four long, highly chitinised filaments. These latter form a retractile loop, which, when prepared for microscopical study, frequently

becomes separated. Not very widely separated from the rostrum are the two pairs of spiracles which are frequently accompanied by grouped glands ("parastigmatic glands," Green). The free abdominal segments vary in number and character from a rounded to a tuberculate form, and frequently bear a number of dorsal tubular spinnerets, and occasionally a few spines.

The pygidium (Fig. 11), which consists of several segments fused together, is a flat chitinised organ

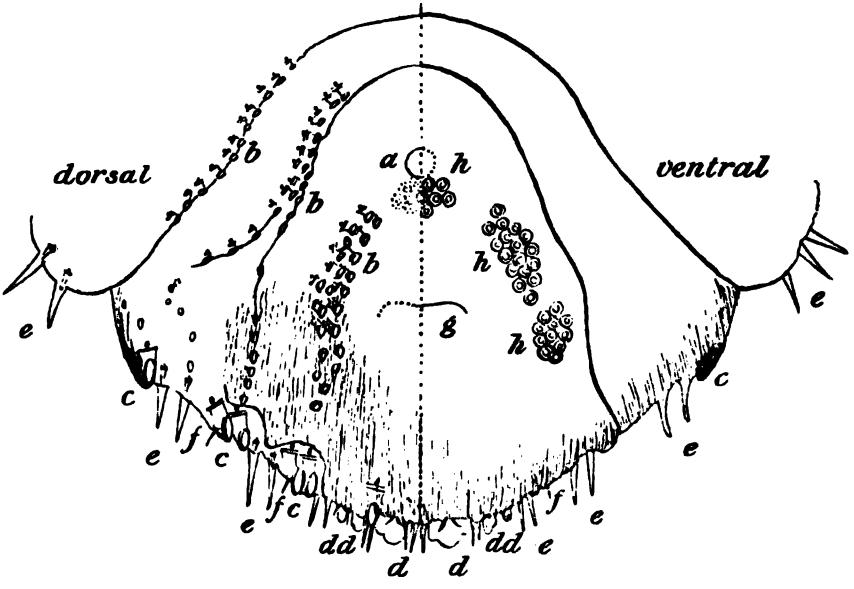

FIG. 11.—Pygidium of *Mytilaspis pomorum*, ♀, × 250; showing dorsal and ventral parts: *a*, anal opening; *b*, dorsal tubular spinnerets; *c*, marginal tubular spinnerets with their more or less projecting pores; *d*, median, second, and third pairs of lobes; *e*, plates; *f*, spines; *g*, vaginal opening; *h*, anterior, anterior lateral, and posterior lateral grouped circumgenital glands.

affording the salient characters for the separation of the species. On the dorsal surface of the pygidium is placed the anal opening (Fig. 11, *a*), and usually a varying number of secreting pores with connecting

tubes (dorsal tubular spinnerets, Fig. 11, *b*). On the ventral surface is the vaginal opening (Fig. 11, *g*), surrounding which there are frequently groups of glands (circumgenital glands, Fig. 11, *h*), which are apparently absent in all the viviparous species; along the margin there may be four distinct organs, viz.—

Fig. 11, *c*, pores: tubular spinnerets, either recessed, or forming conspicuous projections.

Fig. 11, *d*, lobes: of these there are from one to four pairs; they are the most conspicuous organs, are broad, have the margins rounded, lobate, notched, or serrate. Probably used to strip off the epidermal hairs, etc., of the plant.

Fig. 11, *e*, plates: hollow secreting organs, resembling large spines; or bifurcate, to broadly palmate with long fringes.

Fig. 11, *f*, spines.

For other types of pygidia see Plates II, VII, X, XVI, XVII, XXXIII, and XXXIV, and elsewhere.

Male Second Stage.

(Pl. XX, fig. 7.)

The second-stage male closely resembles that of the female in being apterous and apodous, and possessing a rostrum and pygidium with tubular spinnerets.

Pupa.

(Pl. XX, figs. 8, 9.)

In this, the third stage, the insect loses all trace of the mouth-organs, but possesses rudimentary legs and antennæ, wings, and stylus. At first the appendages are short, but they lengthen out before the final change. When the latter takes place the moulted skin is ejected at the posterior extremity of the puparium.

Male.

The majority of males possess wings, but a few species are apterous, and, exceptionally, both forms occur in the same species. Viewed from above the

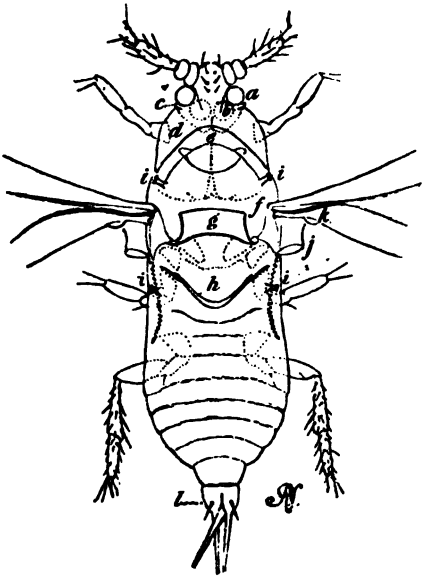

Fig. 12.—Male of *Mytilaspis pomorum*, after treatment with potash, × 70: *a*, dorsal ocelli; *b*, ventral ocelli; *c*, rudimentary eyes; *d*, genæ; *e*, prothorax; *f*, mesothorax; *g*, apodema on mesothorax; *h*, scutellum on metathorax; *i*, spiracles on *ventral* area; *j*, halter; *k*, lobular appendage of wing to receive hooked bristle of halter; *l*, basal portion of genital armature (stylus). The parts indicated by dotted lines are ventral. (See also Pl. XXIV, fig. 8.)

head is more or less triangular in outline, the apex in front usually projects between the antennæ; but its articulation with the thorax is not always clearly defined. The antennæ usually consist of ten joints, and are placed closely together at the extreme margin in front; each joint is generally provided with fine

hairs, the latter on the apical joint being frequently knobbed (Pl. XXV, figs. 4 and 5). Four large prominent ocelli are usually present, the upper pair (Fig. 12, *a*) placed just within the margin behind the antennæ; the second pair, on the ventral surface considerably within the margin, are not very widely separated (Fig. 12, *b*). The true eyes (Fig. 12, *c*), minute colourless organs often difficult to trace, are placed between the anterior margin of the genæ and the large dorsal ocelli. The genæ (Fig. 12, *d*) are large, lobe-shaped organs extended backwards, and overlap and constrict the anterior margin of the thorax. The latter is very large and occupies about one half of the whole body; of its three component parts the prothorax (Fig. 12, *e*) is less defined than the others; dorsally the mesothorax (Fig. 12, *f*) bears a broad chitinous band (apodema, Fig. 12, *g*) at its posterior extremity, which forms a conspicuous feature, as it generally has a highly polished surface, and is often coloured darker than the rest of the thorax; on its ventral surface is a broad scute, with a central division, widest in front, sides and posterior margin continuously rounded. The metathorax bears a large rounded triangular or shield-shaped scutellum (Fig. 12, *h*), having a delicate epidermis not highly chitinised.

The single pair of wings attached to the mesothorax are very narrow at the base, but gradually widen out and have broadly rounded tips; they usually extend beyond the stylus, but in a few species they are more or less rudimentary. The lower pair of wings are represented by halteres (Fig. 12, *j*), consisting of an elongated tubercle bearing a stout-hooked bristle which fits into a little upturned portion of the wings (Fig. 12, *k*). The legs are usually long, slender, and hairy; have a single-jointed tarsus, with a simple claw and from two to four knobbed hairs (digitules); they are attached respectively to the pro-, meso- and metathorax.

The abdomen, of nine segments, is often longitudinally furrowed just within the margins; the anal

segment consisting chiefly of the long stylus (Fig. 12, *l*) or genital sheath, which carries the penis.

The males of all the Diaspinæ are remarkable for their constancy of form; they offer no salient characters by which they could be generically separated.

Synopsis of Genera.

The characters of the British Diaspinæ are given in the synoptical table below.

A. Puparium of the male coriaceous or horny, resembling somewhat that of the female, more or less circular or ovate; larval exuviæ central or subcentral.

Puparium of female circular or subcircular, rarely elongate; exuviæ superposed, central or subcentral. Adult female with not more than five groups of circumgenital glands. Dorsal tubular spinnerets usually present.

(I) . . . . Aspidiotus (1).

Puparium of *adult* female consisting entirely of the naked moulted skin (exuviæ) of the second-stage female. Larval exuviæ wanting. Adult female without grouped glands. Dorsal tubular spinnerets wanting.

(II) . . . . Gymnaspis (2).

B. Puparium of the male closely felted; narrowly elongate, with or without carinæ; usually white. Larval exuviæ at cephalic extremity.

b. Dorsal tubular spinnerets in adult female irregular.

Puparium of adult female subcircular. Exuviæ, always within the margin, are usually subcentral. Male puparium tricarinate. Adult female with not more than five groups of circumgenital glands.

(III) . . . . Diaspis (5).

Puparium of adult female elongate, or approximately circular. Exuviæ at margin or projecting beyond it. Male puparium non-carinated. Adult

female with not more than four groups of circumgenital glands; margin of pygidium with large tubular spinnerets, the pores of which are recessed, giving the margin a crenulated character.

(IV) . . . PARLATORIA (4).

b. b. Dorsal tubular spinnerets forming distinct bands.

Puparium of adult female pyriform or subcircular. Exuviæ invariably terminal in the second-stage female; those of the adult either at margin or just within it. Not more than five groups of circumgenital glands in adult female. Male puparium carinated.

(V) . . . . AULACASPIS (6).

Puparium of adult female elongate, widened posteriorly. Exuviæ always at the cephalic extremity. Adult female possessing more than five groups of circumgenital glands. Male puparium non-carinated.

(VI) . . . . POLIASPIS (7).

Puparium of adult female pyriform, as in the preceding; exuviæ terminal. Adult female with not more than five groups of circumgenital glands. Male puparium carinated.

(VII) . . . CHIONASPIS (8).

b. b. b. Dorsal tubular spinnerets absent; circumgenital glands in not more than five groups. Puparium of adult female consisting chiefly of the moulted skin (exuviæ) of the second-stage female, which completely encloses the adult insect. Larval exuviæ terminal. Male puparium carinated.

(VIII) . . . . FIORINIA (3).

C. Character of male puparium doubtful.

Puparium of adult female elongate, with exuviæ terminal; that of the second-stage female very large, but *not* enclosing the adult insect.

(IX) . . . PINNASPIS (10).

D. Puparium of the male coriaceous or horny; narrowly elongate, with the exuviæ terminal. Resembles that of the female, but much smaller.

d. Circumgenital glands in adult female in not more than five groups. Dorsal tubular spinnerets forming irregular bands. Puparium of adult female mytiliform; exuviæ terminal. Male puparium with a hinge-like structure towards the posterior extremity.

(x) . . . . MYTILASPIS (9).

d. d. Circumgenital glands in adult female in not more than three groups. Dorsal tubular spinnerets absent or quite rudimentary; their places occupied by a large lattice-shaped thickening of the dermis. Female puparium very long and narrow; male puparium not hinged.

(xi) . . . ISCHNASPIS (11).

GENUS ASPIDIOTUS (Bouché).

Female puparium more or less circular, rarely ovate; varies from low convex to limpet-shaped, or obconical. Exuviæ central or subcentral, invariably occupy the highest portion, and are superposed; secretionary covering either thin and transparent or thick and opaque; that which covers the larval exuviæ often forms a nipple-shaped prominence. The thin secretionary covering rarely remains intact for any length of time, and when absent reveals the true character and colour of the exuviæ.

Ventral scale usually remains attached to the plant, and varies from a delicate farinose secretion to a stout pellicle.

Male puparium coriaceous or horny, oblong-ovate, is much smaller, but generally resembles that of the female.

The females show great variation in the character of

the pygidium, as will be seen on studying the figures on Pls. II, IV, VII, and X. Chiefly by the characters of these organs Professor Berlese and Mr. Cockerell have established several new sub-genera. Such a division is very convenient for working out all the known species; I do not, however, deem it advisable to subdivide the comparatively few species found in this country.

Synopsis of the Species.

A. Pygidium without circumgenital glands.

a. ♀ with a large cephalic projection of the body; lobes rudimentary. Puparium obconical, blackish.

(I) . . . . . Personatus.

b. Pygidium with three pairs of rudimentary lobes; dorsal pores large. Puparium high convex, brown; exuviæ black.

(II) . . . . . Bromiliæ.

b b. Puparium flat convex; exuviæ dull orange yellow.

(III) . . . . . Aurantii.

c. Pygidium with one pair of well-developed lobes, margin of same deeply incised. Puparium high convex; exuviæ yellow.

(IV) . . . . . Camelliæ.

B. Pygidium with four, rarely with five, groups of circumgenital glands.

a. Short serial group of lateral dorsal pores absent. Puparium reddish-pink in the young, smoky grey in the old examples.

(V) . . . . . Zonatus.

C. Pygidium always with five groups of circumgenital glands.

a. Serial group of dorsal pores present. Puparium flat convex, grey with a darker central zone.

(VI) . . . . Ostreæformis.

D. Pygidium always with four groups of circumgenital glands and marginal club-shaped glands.

a. Pygidium with five pairs of club-shaped glands; dorsal tubular spinnerets extending into first free abdominal segment. Puparium convex, purplish black.

(VII) . . . . . FICUS.

a a. Tubular spinnerets not extending into free abdominal segment. Puparium rich orange brown.

(VIII) . . DICTYOSPERMI, var. ARECÆ.

b. With six pairs of club-shaped glands. Puparium purple brown.

(IX) . . . . . ALIENUS.

c. With seven pairs of club-shaped glands.

(X) . . . . . PERSEÆ.

D D. Pygidium without club-shaped glands.

a. With one pair of well-developed lobes; spines as long again as lobes. Puparium high convex, grey.

(XI) . . . . . SPINOSUS.

b. Groups of tubular spinnerets connected with pores on both surfaces of pygidium; circumgenital glands almost continuous. Puparium bright fulvous.

(XII) . . . . . BRITANNICUS.

c. Spiracles of ♀ reticulated. Tubular spinnerets short. Puparium flat convex, opaque white or ochreous.

(XIII) . . . . . HEDERÆ.

c c. Tubular spinnerets long. Puparium semitransparent, showing sublying female.

(XIV) . . . . . CYANOPHYLLI.

E. Pygidium with two groups of circumgenital glands.

a. Body deeply divided between thoracic and abdominal segments.

(XV) . . . . . ARTICULATUS.

ASPIDIOTUS PERSONATUS (Comstock).

(Pl. III, figs. 9—13; Pl. IV, fig. 1; Pl. XI, fig. 5.)

Aspidiotus personatus, Comstock; Second Report, 1883, p. 66, pl. iii, fig. 2—2*a*.

Mycetaspis personatus, Cockerell; the San José Scale and its nearest allies (Tech. Ser. No. 6, U.S. Dept. of Agriculture, Div. of Ent., Washington, 1897, p. 24).

Aonidiella personata, Leonardi; Gen. e sp. di Diaspiti. Estratto dalla Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII], p. 148.

Puparium of the female (Pl. III, figs. 9, 13), obconical or thimble-shaped, the height almost equalling the greatest diameter, surface roughly and irregularly laminate, but shining, usually tilted to one side. Colour black, blackish brown, piceous, or sometimes smoky grey; laminæ grey or white; denuded examples more polished than those with the laminæ perfect. Exuviæ, at the highest part of the puparium, dull red, secretionary coverings black, the extent of each indicated by white concentric rings, and there is usually a central boss or nipple. Ventral scale (Pl. III, fig 10) about half the greatest diameter of the whole ventral surface; unicolourous pale brown. The remainder of the ventral surface consists of a broad, thick flange, which is undoubtedly a continuation of the upper part of the puparium. A very thin secretion generally remains attached to the plant (Pl. III, fig. 11) which is ochreous, with two small dark concentric rings, followed by others of pale blue and dark brown. Tissues of the leaf immediately surrounding these dull orange.

Diameter ·75 to 1 mm.

Adult female (Pl. III, fig. 12) almost circular, with a large cephalic projection of the body. Rudimentary antennæ a group of minute spines. Base of rostrum

unusually large, mentum comparatively small, unexpanded filaments extending beyond middle of pygidium. Pygidium (Pl. IV, fig. 1) very broad, indistinctly articulated to first free abdominal segment, taking practically the same contour as the body, and only slightly produced at the extremity. Vaginal opening central. Anal opening towards the apex. There are two subdorsal groups of long, filiform, tubular spinnerets, apparently connected with minute marginal pores; there is no trace of the dorsal pores to which similar tubes are usually connected in other species. Margin of pygidium (Pl XI, fig. 5) with six pairs of very short lobes; the median pair, usually the longest, are triangular, entire, or have the anterior margin faintly notched; the second pair, much shorter, have one or more notches on the anterior margin; the third pair twice as broad as the second, and have the anterior margin finely but roundly dentate; the remaining three are very broad, have a similar dentate margin, and at their base a continuous palisade-like structure, probably due to the thickening of the dermis. The plates are short, rudimentary, and spine-like; the three between the third and fourth lobe are the most conspicuous. Spines all very small; the first immediately following the median lobes; the next the second lobe; and the third and fourth opposite the lobes; beyond the lobes there is usually one or more very minute ones. Within the body-wall are six long, club-shaped glands which are connected with minute pores at the margin; there is one between the median and second lobe, and another between the second and third lobe; the two next are placed together between the third and fourth lobe.

I doubt very much if the three pairs of extra lobes (fourth, fifth, and sixth) are anything more than marginal extensions of the body-wall, there being no line of separation from the body as in the case of the other lobes.

Puparium of the male elongate ovate, anterior half

obconical; finely rugose; is of a dark purplish-brown colour, and has grey particles of the epidermal layer of the food-plant mixed with the secretion. Exuviæ, in the centre of the anterior half, covered with greyish-brown secretion forming two distinct concentric rings. Ventral surface highly polished, but strongly punctured; apical portion farinose. Ventral scale a thin secretion on the leaf.

Long. ·80 mm.

Male second stage. Short ovate, widest at abdominal segments. Colour dark translucent yellow.

Habitat.—Under glass, Royal Gardens, Kew; on *Tillandsia confertiflora*, *T. Saundersii*, and *T. corallina*; on which plants it was thoroughly well established, and very common at the time of my visit in July, 1896, and in April, 1897.

Distribution.—Its home is apparently in the West Indies; as Professor Comstock's types were from Cuba. I have received it also from several sources in Jamaica; and Mr. Douglas records it from British Guiana.

Descriptions of the Plates.

Pl. III, fig. 9.—Puparia of adult female in profile. × 25.

Fig. 10.—Puparium of adult female, ventral view, with portion of ventral scale broken away, revealing the female within. × 25.

Fig. 11.—Basal layer of ventral scale attached to leaf, and surrounded by zone of discoloration of the leaf-tissues. × 25.

Fig. 12.—Adult female after treatment with potash. × 50.

Fig. 13.—Insects natural size *in situ* on portion of leaf of *Tillandsia*.

Pl. IV, fig. 1.—Pygidium of adult female. × 250.

Pl. XI, fig. 5.—Margin of pygidium of adult female. × 600.

Aspidiotus bromiliæ, Newstead, MS.

(Plate III, figs. 1—5; Plate IV, fig. 2; Plate XI, fig. 6.)

Aonidiella bromiliæ (Newst.), Leonardi; Gen. e sp. di Diaspiti. Estratto da. Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII].

Puparium of adult female (Pl. III, figs. 1—3), high convex, usually pyriform, narrowed, and attenuated *posteriorly* with the cephalic margin widely rounded. In some instances the posterior extremity of the scale is slightly reflexed, due, apparently, to its position upon the food-plant. The rarer forms of the scale are widely ovate, or almost circular (Pl. III, fig. 1); but all are narrowed posteriorly. Colour varying from pale ochreous to dark ochreous brown, or blackish brown. Exuviæ at the larger end of the scale, towards the cephalic margin, shining black; first secretionary covering convex, thin, smooth, and grey, or ochreous grey, but rarely present in the old adults; second secretionary covering convex, of nearly the same colour as the scale, and is present in all the examples before me. Ventral surface piceous, or madder brown; faintly punctate; and has a thin greyish, mealy deposit; margin narrowly pale ochreous. Ventral scale complete, very thick; almost invariably breaking away in a circular or operculate form, remaining attached to the food-plant, and exposing the female within the scale. That portion which encloses the narrow posterior extremity usually remains intact; forming a somewhat flat, horn-shaped cavity and a receptacle for the eggs (Pl. III, fig. 2).

Long. 2—2·25 mm.

Scale of the immature female (Pl. III, fig. 3) elongate or circular; colour a little brighter than those of the adults; under side dark castaneous or madder brown and shining. Exuviæ central, are usually piceous.

Female adult (Pl. III, fig. 2), short, ovate, or almost circular. At the period of gestation the body becomes tumid and the segmentation indistinct. Colour varying from very pale to dark mauve or dull purple. Pygidium (Pl. IV, fig. 2) distinctly articulated with the body. Circumgenital glands wanting. Subdorsal groups of tubular spinnerets filiform, the longest extending beyond the vaginal opening; the connecting dorsal pores in two short divergent series on either side of the meson; median group of tubular spinnerets consists of five or six, are connected at the apex, and all along the margins are many minute tubular spinnerets of a similar character. Immediately anterior to the dorsal pores is a very long, slender, club-shaped gland, which is connected with the extreme margin. Vaginal and anal openings practically opposite. Margin of pygidium (Pl. XI, fig. 6) with three pairs of rudimentary lobes; the median pair are usually entire and widely rounded; the second and third, nearly as broad again as the first, are either emarginate or irregularly notched on the hind margin. In some examples there is also a fourth lobe, much longer than the others, which has a bluntly serrate hind margin, but is so very narrow as to be scarcely distinguishable from the true margin of the pygidium. The plates are rudimentary, spine-like, and arranged in pairs between the lobes, at the base of which there is usually a marginal pore. Within the body are four pairs of comparatively short club-shaped glands connected with the spaces between the lobes, the second pair being much the longest.

Puparium of the male (Pl. III, fig. 4) elongate. Colour pale purplish brown; margin paler; with a somewhat ochreous, mealy surface. Exuviæ towards the cephalic margin shining black. Secretionary covering pale greyish or white.

Long. ·75—1 mm.

Perfect male unknown.

Habitat.—Chester, on pine apples, said to be imported from the Canary Isles. My first examples were dis-

covered by Miss Tomlin in 1890. Subsequently, in 1897, I found a number of these insects on pine apples exposed for sale in this city (Chester). This was in the month of April, and although the fruit had been exposed to the open air for several days, both females and larvæ were living, and appeared none the worse for their sudden exposure to a much colder climate. The same fruit harboured colonies of *Diaspis bromeliæ* in all stages.

This insect is remarkable for the singular structure of the female puparium, which differs from all other species of this genus in being narrowed and complete at the posterior extremity.

Description of the Plates.

Pl. III, fig. 1.—Puparium of adult female, dorsal view, showing naked black exuviæ. × 25.

Fig. 2.—Puparium of adult female, ventral view, with greater portion of ventral scale broken away, showing the adult insect and the eggs at the narrow posterior extremity. × 25.

Fig. 3.—Puparium of the female second stage. × 25.

Fig. 4.—Puparium of the male. × 25.

Fig. 5.—Insects natural size *in situ* on portion of pine-apple fruit.

Pl. IV, fig. 2.—Pygidium of adult female. × 250.

Pl. XI, fig. 6.—Margin of pygidium of adult female. × 600.

Aspidiotus aurantii (Maskell).

(Plate I, figs. 1—6; Plate II, fig. 1; Plate XI, fig. 1.)

Aspidiotus aurantii, Maskell; Trans. N.Z. Inst., vol. xi, 1878, p. 199.

Aspidiotus citri, Comstock; Canadian Entomologist, vol. xiii, p. 8.

Aspidiotus coccineus, Gennadius; Ann. de la Soc. Entomol. de France, Ser. 6, Tom. 1, 1881, p. 189.

Aonidia gennadii, Targioni-Tozzetti; Annali di Agric., 1881, p. 151.

Aonidiella aurantii, Berlese; Le Cocciniglie Italiane, Part iii, p. 212. Leonardi; Gen. e sp. di Diaspiti. Est. da. Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII], p. 124, fig. 141.

Puparium of the female (Pl. I, figs. 1, 2, 6) circular, margins broadly flat, median area low convex. Colour pale yellowish grey, or pale ochreous; semitransparent; revealing the form and colour of the insect beneath it. Exuviæ central; dull orange yellow above; beneath bright orange yellow and very shiny. First secretionary covering nipple-shaped, its colour varying from white to pale ochreous; the second, flat and pyriform, varies from pale ochreous to orange brown. Ventral scale thin at the centre, but stout towards the margin; it is firmly attached to the dorsal scale, and to the body of the female, from which it is with difficulty separated, and generally comes away in patches as shown at Pl. I, fig. 2. The rostrum is placed a little to one side of the centre, its position being clearly indicated in the ventral scale.

Diam. 1–2 mm.

Adult female at period of gestation (Pl. I, fig. 2) almost circular; pygidium partly contracted within the body; the abdominal segments forming two convergent lobes. At this stage the body becomes chitinised and retains its form. Colour pale dull orange. The early adult (Pl. I, fig. 4) is broadly pyriform, with the pygidium produced (a form which the adult female assumes after treatment with potash, Pl. I, fig. 3). Rostrum near the centre of the body; filaments extending to second pair of spiracles. Margin of cephalic and thoracic area, broadly and irregularly reticulate, with numerous elongated thickenings. Pygidium (Pl.

II, fig. 1) well defined. Circumgenital glands absent. Vaginal opening a little above the centre. Anal orifice towards the extremity. There are two groups of long, filiform, tubular spinnerets connected with two double, irregular rows of about fourteen dorsal pores; and there is also a small central group connected with three dorsal pores opening near the margin between the second and third pair of lobes. Immediately above the tubes are four conspicuous, equidistant scars. Margin (Pl. XI, fig. 1) with three pairs of well-developed lobes; median and second pair usually notched or emarginate at the sides, in front; third pair, smallest, are usually notched on the outer margin. All the lobes extend considerably within the body, and have the margins curved inwards and thickened. Plates very long and deeply cut; two in each space between the lobes, and three beyond. The first plate between the second and third lobe, and the three beyond, completely divided by a deep central cleft; the inner portion being simple or with faint serrations; the outer with a deep blunt fringe. The spines are short, and placed at the base of the lobes, and there is usually one just beyond the plates.

Scale of the male (Pl. I, fig. 5) oblong, somewhat narrowed at the anal extremity. Exuviæ towards the margin in front of the same colour and structure as that of the female.

Long. 1 mm.

Perfect male not observed in this country; but Maskell describes it as orange yellow with a dark brown apodema.

Habitat.—In Chester on Jaffa oranges, probably imported from the Mediterranean area. Although large numbers of Coccids find their way to our markets on imported fruit, I have only once met with this species during the last six years. It seems exclusively confined to the orange and lemon, but as Coccids are such general feeders, it is just possible this species may establish itself on some of the exotic plants cultivated

in this country; care should therefore be taken not to allow infested fruit to be placed near cultivated plants.

Distribution.—Is abundant and destructive to orange and lemon trees in New Zealand, Australia, Ceylon, United States of America, and parts of the Mediterranean area.

Explanation of the Plates.

Pl. I, fig. 1.—Puparium of adult female, dorsal view. × 25.

Fig. 2.—Puparium of adult female, ventral view, with part of ventral scale removed showing female within. × 25.

Fig. 3.—Adult female after treatment with potash. × 50.

Fig. 4.—Parasitised immature female removed from the puparium. × 25.

Fig. 5.—Puparium of male.

Fig. 6.—Insects natural size *in sitû* on orange rind.

Pl. II, fig. 1.—Pygidium of adult female. × 250.

Pl. XI, fig. 1.—Margin of pygidium of adult female. × 600.

Aspidiotus camelliæ (Signoret).

(Pl. III, figs. 6—8; Pl. IV, fig. 3; Pl. XI, fig. 3.)

Aspidiotus camelliæ, Signoret; Essai, p. 117.

Aspidiotus rapax, Comstock; Report, 1880, p. 307, pl. xii, fig. 6.

Aspidiotus cuonymi, Targioni-Tozzetti; Est., Boll. Soc. Toscana Ortic., Anno xiii, 1888, p. 12.

Aspidiotus flavescens, Green; Insect Pests of the Tea Plant, 1890, p. 21.

Diaspis circulata, Green; Catalogue Coccidæ of Ceylon, Ind. Mus. Notes, vol. iv, No. 1, 1896.

Hemiberlesia (Aspidites) *camelliæ*, Leonardi; Gen. e sp. di Diaspiti. Est. da. Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII], p. 23.

Puparium of the female (Pl. III, figs. 6, 8) high convex; limpet-shaped; oblong or broadly pyriform; anterior portion highest, apex usually curved towards the front margin. Texture partaking somewhat of the character of the food-plant, owing to the admixture of hairs and surface tissues, which the female separates and mixes with the secretion. On hard-wooded plants, such as the Camellia, the scale is free from the admixture of foreign substances. Exuviæ at the apex of the scale, which is towards the anterior margin; and in the curved or limpet-shaped examples it occupies an almost vertical position; colour dark-red brown or piceous. Secretionary coverings circular; the first forming a central boss and ring of white secretion, the second, of the same colour as the first, is without design.

Ventral scale complete, with a central circular depression; pure white, and rarely stained; and in the last stage it becomes very thick and readily separates from the dorsal portion, but usually remains attached to the food-plant, forming a small conspicuous white spot (Pl. III, fig. 8).

Greatest diameter 1—2·50 mm.

The puparium of the second-stage female is circular, with the exuviæ central.

Female adult (Pl. III, fig. 7). Short, ovate, narrowed and slightly produced behind; segmentation distinct. Colour bright yellow or orange yellow; apex of pygidium red brown. At the advanced stage of gestation the insect becomes broadly ovate, the segmentation disappears almost entirely, and the ova can be seen in the interior of the body as small purplish-brown bodies. Pygidium (Pl. IV, fig. 3) widely rounded and rather short. Circumgenital glands absent. Subdorsal tubular spinnerets, very short, filiform, and number from five

to seven; they are connected with a corresponding number of dorsal pores, which are circular and unusually small. There are usually four dermal scars, but the central pairs are sometimes united. Anal opening very large and near the margin. Vaginal opening at the commencement of the second-third of the space from the base. Margin (Pl. XI, fig. 3) with the median lobes well developed and unusually large; their lateral margins are either straight or slightly curved; and the hind margin is usually notched at the angles, but sometimes has a wavy outline; the second and third pairs of lobes are very minute, and pointed. The two plates between the median lobes are long and slender, and have two or three points; the next five are irregularly furcate or branched, and very long; there are usually two simple plates beyond the third lobe, the farthest being much the shortest. There is a long spine at the base of each lobe at the anterior margin; and an isolated pair considerably beyond the last plate, which are somewhat longer.

There are two deep incisions in the body-wall, one between the median and second lobe, and the other between the second and third lobe; the margins of the incisions are strongly chitinised and thickened.

Habitat.—Under glass, on *Myrtle*, *Camellia*, *Euonymus*, *Euphorbia*, *Asparagus plumosus*, *Begonia*, cultivated fig, etc. In Cheshire and Lancashire it is apparently common, and very generally distributed. Mr. Douglas was the first to record the species from Exeter. I am not aware of its occurrence elsewhere, but from experience I should imagine it will occur in almost every neglected greenhouse and conservatory in Great Britain.

Distribution.—It occurs in the open air in the south of Europe, and has been taken in Algeria by the Rev. Eaton. But I have not heard of its occurrence in other parts of Africa. Elsewhere it is a common pest, and very generally distributed.

Habits.—The females are universally parthenoge-

netic, and there appears to be a succession of broods produced throughout the year. Prof. Comstock found dead examples of the males, but they were shrivelled and imperfect. I believe a living male has not been seen in any part of the world; and I have never seen any trace of the puparia in this country.

The worst attack I ever saw of this coccid was at High Legh, Cheshire, where it had almost covered the branches and leaves of a number of fig-trees, and it was found necessary to have the plants cut down and destroyed.

Explanation of the Plates.

Pl. III, fig. 6.—Puparium of adult female. × 25.
Fig. 7.—Adult female at period of gestation. × 30.
Fig. 8.—Insects actual size *in situ* on leaf of Camellia.
Pl. IV, fig. 3.—Pygidium of adult female. × 250.
Pl. XI, fig. 3.—Margin of pygidium of adult female. × 600.

Aspidiotus zonatus (Frauenfeld).

(Pl. VI, figs. 1—9; Pl. VII, fig. 1; Pl. XII, fig. 2.)

Aspidiotus zonatus, Fraunefeld; Verhandl. Zool. B. Gesells. Wien, 1868, p. 888. Signoret, Essai, p. 135.
Aspidiotus quercus, Signoret; Essai, p. 132.
? Aspidiotus pyri, Licht.; Bull. Soc. Ent. France, p. li, 1881.

Puparium of the adult female (Pl. VI, figs. 1, 9) approximately circular, moderately convex; other forms occur due to compressure by overcrowding, or by contact with prominent portions of the bark. Colour smoky grey or ochreous grey. Exuviæ a little towards the margin, rarely central; vary from yellow to dark

orange yellow. Form and colouring of secretionary covering uncertain, as it invariably disappears in the old examples. The old scales become so covered with a sooty deposit as to render their colour perfectly obscure; the only recognition mark being the minute orange-coloured larval exuviæ. The ventral surface of the puparium is greyer, and the larval exuviæ brighter. Ventral scale a thin powdery secretion, forming conspicuous white circles on the bark (Pl. VI, fig. 9).

Diameter ·75—1·75 mm.

Adult female (Pl. VI, fig. 3) widely ovate, almost circular, and shrivelling after gestation. Pygidium well defined and projecting. Colour clear, bright, yellow; margin of pygidium darker, or orange brown. After treatment with potash the insect assumes a more regular ovate outline, the pygidium taking the same contour as the body. Cephalic area with many slender hairs and several shorter ones irregularly placed along the margin at the sides of the body. Rostral filaments more than twice the length of the mentum. Free abdominal segments, with several tubular spinnerets connected with marginal pores. Pygidium (Pl. VII, fig. 1) broad and comparatively short. Subdorsal groups of tubular spinnerets moderately short; connecting dorsal pores in a short double series; the outer series irregularly alternate. Vaginal opening a little beyond the centre. The anal opening nearly half way between the apex and vaginal opening. Circumgenital glands in four, or rarely five groups; the anterior group of from 1—4; the anterior laterals from 8—14; and the posterior laterals from 6—11. The following formula of twelve examples are from a single colony of females:

0	0	0	0	0	0
10—8	11—10	9—10	14—13	9—10	11—10
9—7	8—10	8— 8	7— 8	6— 6	8— 7
0	0	1	3	3	4
11—11	10—11	10—11	12—9	14—13	10—12
10— 9	10— 7	8—10	8—8	9—11	9—11

Margin of pygidium (Pl. XII, fig. 2) with three pairs of lobes; the median pair well developed, very broad, usually with a small notch at the extremity of the inner margin, and a larger one at the extremity of the outer; sometimes they are widely rounded, and have a faint lateral emargination. The second and third pairs are more or less rudimentary; the former the narrowest; both have the posterior margin sloping outwards, and have an irregular, wavy, notched, or entire outline. The median pair of plates are spine-like; the second pair simple, bifurcate, or finely serrate; the two between the second and third lobes are broad at the base, and deeply furcate. There are usually five short spines on either side of the meson, of which the first are slightly the longest, and placed at the outward base of the median lobes; the second and third over the second lobe; the fourth over the third lobe; and the fifth a little beyond. Body-wall incised, strongly chitinised, and thick at the base of the second and third groups of plates.

Scale of the second-stage female (Pl. VI, fig. 2) circular; dull reddish pink with a white margin. Exuviæ central. Cabinet specimens become pale ochreous or white, and have a somewhat mealy surface.

Female at period of fecundation broadly pyriform, and pale yellow; pygidium reddish brown.

Scale of the male (Pl. VI, fig. 4) elongate, usually narrower in front than behind. Straw-coloured, or pale ochreous. Exuviæ central and yellow. Secretionary covering, with a faint central prominence, is very thin at the margin, where the yellow colour of the larval exuviæ shows through.

Long. 1 mm.

Male (Pl. VI, fig. 5) bright yellow; legs and antennæ dusky yellow or colourless; margins of mesothoracic plates a little dusky. Eyes and apodema intense shining black; wings hyaline. Antennæ of ten joints, all with numerous long hairs; the apical joint (Pl. VI, fig. 6) with four long knobbed hairs. The legs are similarly

clad with hairs, and the tarsus (Pl. VI, fig. 7) has a fine sharp claw and four knobbed hairs. Stylus about three fourths the length of the body.

Larva pale yellow; with six-jointed, funiculate antennæ like those of *A. ostreæformis*. Caudal setæ long; between them a pair of short spines. Mesal lobes well developed; margin beyond them with four or five tuberculate projections, each bearing a minute spine.

Ova yellow.

Habitat.—On oak (*Quercus robur*); at High Legh (Gillanders), and Eaton in Cheshire; Bearsted (Green), Orpington and district, Chislehurst, Frant Wood (Saunders); and Lewisham (Douglas), in Kent. I find it most abundant in Cheshire, but it never occurs in such numbers as the preceding species. Mr. Watkins has sent me the species from Painswick, but I have found it very sparingly elsewhere in Gloucestershire.

This species is so closely allied to *A. ostreæformis* that a comparative statement is necessary. The following table gives the salient characters of each:

♀ *A. ostreæformis.*	♀ *A. zonatus.*
Body highly chitinised.	Body not highly chitinised.
Circumgenital glands always in 5 groups.	Circumgenital glands usually in 4 groups.
Series of basal pores near base of pygidium.	None.
Lobes in two pairs.	Lobes in 3 pairs.
Spines long.	Spines short.
♂ antennæ with 8 knobbed hairs at apex.	♂ antennæ with 4 knobbed hairs at apex.

Distribution.—Widely distributed, and common in many parts of Europe.

Habits.—Egg-laying takes place early in May, and although I have not observed the larvæ, I should imagine they hatch soon afterwards, as the puparia are

formed by the end of the summer. The male larvæ fix themselves upon the under sides of the oak leaves, generally near the ribs; the females invariably upon the branches, near the tips, behind the bud scales, or on the thicker branches, far away from their partners. The males begin to appear about the last week in August, and few are seen after the first week in September. The surviving females hybernate throughout the winter, no apparent change taking place until spring, when the body increases in size, shrivels during gestation, and the insect dies. The females slightly predominate, and I imagine are often parthenogenetic, as many examples fix themselves in quite inaccessible places. The females are frequently parasitised, but I have not been fortunate in rearing the parasite.

During the winter months, when insects are comparatively scarce, this species is freely eaten by certain insectivorous birds. See chapter on "Natural Enemies of the Coccidæ," pp. 33—41.

Explanation of the Plates.

Pl. VI, fig. 1.—Puparium of adult female covered with sooty deposit; larval exuviæ naked. × 25.

Fig. 2.—Puparia of immature females as found behind the bud-scales in autumn. × 25.

Fig. 3.—Adult female at period of gestation. × 35.

Fig. 4.—Puparium of the male on portion of oak leaf. × 25.

Fig. 5.—Male. × 50.

Fig. 6.—Apical joint of male antennæ. × 600.

Fig. 7.—Tarsus and claw of male. × 600.

Fig. 8.—Male puparia, natural size, *in situ* on under side of oak leaf.

Fig. 9.—Puparia of the female, natural size, *in situ* on oak branch.

Pl. VII, fig. 1.—Pygidium of adult female. × 250.

Pl. XII, fig. 2.—Margin of pygidium of adult female. × 600.

ASPIDIOTUS OSTREÆFORMIS (Curtis).

(Pl. V, figs. 1–14; Pl. VII, fig. 2; Pl. XII, fig. 1.)

Aspidiotus ostreæformis, Curtis (Ruricola); Gardener's Chron., 1843, p. 805, with fig.

Nec *Diaspis ostreæformis*, Signoret; Essai s. l. Cochen., p. 121, pl. v, fig. 4.

Nec *Diaspis ostreæformis*, Comstock; Report, 1880, p. 311, pl. xv, fig. 4.

Aspidiotus betulæ, Bärensprung; Journal d'Alton et Burm., 1849.

Aspidiotus tiliæ (Bouché), Leonardi; Gen. e sp. di Diaspiti. Est. dal. Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII], p. 65.

Aspidiotus hippocastani (Signoret), Leonardi, l. c.

Aspidiotus oxyacanthæ? (Signoret), Leonardi, l. c.

Aspidiotus tiliæ (Signoret), Leonardi, l. c.

Aspidiotus spurcatus, Signoret Essai, p. 112, pl. iv, fig. 8.

Puparium of adult female (Pl. V, figs. 1—3) more or less circular and moderately convex; examples distorted by overcrowding, or compressed by contact with a prominent portion of the food-plant, very variable; texture smooth. The central third is usually olivaceous black, the remainder dusky ochreous or dark grey. Exuviæ central or, towards the margin in front, dull yellow or bright orange yellow. Secretionary coverings grey or white, the first forming a small central boss, the second in the form of a broad concentric ring. A young example is shown at Fig. 2. The foregoing description applies to typical examples such as one finds upon the *smooth, young* wood of the currant or plum, and which are absolutely free from the admixture of the surface-tissues of the food-plant. On the old wood of the peach the scales are much thicker, almost entirely olivaceous black, and almost completely hidden

beneath the thin epidermal layer of the wood (Pl. V, fig. 3). The examples before me on plum (*Prunus domestica*) have formed a complete homogeneous layer, only recognisable from the bark by the numerous, minute, orange-coloured specks of the larval exuviæ. On removing this mass the bark appears quite white from the numerous powdery ventral scales which adhere to it.

Diam. 1—2 mm.

Adult female short ovate, almost circular, old specimens becoming chitinised; yellow or ochreous yellow. Parasitised examples (Pl. V, fig. 5) broadly pyriform, inflated, usually bright orange brown, and highly chitinised. Rudimentary antennæ a mere stump with a long stiff spine at the base. Rostral filaments scarcely longer than mentum. Free abdominal segments, and margin in front with a few long hairs. Pygidium (Pl. VII, fig. 2) always with five groups of circumgenital glands, the anterior group consisting of from 5 to 8, the anterior laterals from 7 to 12, the posterior laterals from 5 to 16. The formula of twelve examples from a single colony on plum are given below:

5	7	5	6	5	6
8—10 .	9—10 .	8— 7 .	7— 8 .	9— 9 .	6— 7
8—10 .	9— 8 .	5— 6 .	10—11 .	11— 9 .	12—11

6	5	5	8	6	5
11— 7 .	9—10 .	7—11 .	8— 8 .	12—12 .	9— 9
8— 8 .	8—11 .	16—13 .	12—11 .	11—14 .	11— 9

The subdorsal groups of tubular spinnerets, rather short, are connected with a double series of glands or pores. Extending from near the last marginal spine to the base of the pygidium on the dorsum is a series of, usually four, large circular pores. Vaginal opening central. Anal opening about midway between the former and the apex of the pygidium. Margin of pygidium (Pl. XII, fig. 1) with two pairs of lobes; median pair well developed, rounded, and notched at

the sides; second pair broader than the former, but only about half the length, with the hind margin emarginate, or irregularly notched, forming a wavy outline; third pair obsolete. The first pair of plates are simple and spinelike; the second finely serrate; the first two beyond the second lobe simple or bifurcate; the third, usually, deeply and widely serrate. There are usually five long spines on either side—the first at the base of the anterior margin of the median lobes; the second and third, opposite, are attached to the base of the second lobe; the fourth and fifth considerably beyond, equidistant from the second, and somewhat longer. The body-wall is considerably thickened and chitinised at the base of the plates.

The second-stage female possesses no ventral circumgenital glands; these organs are not developed until after the final moult.

Scale of the male (from typical examples on currant) short ovate; posteriorly extended and widely rounded. Colour olivaceous black, with the posterior extension grey. Examples on the old wood of the plum (Pl. V, fig. 7) elongate, thick, and of a rough texture owing to the admixture of epidermal tissues of the bark. Colour olivaceous black, except at the posterior extremity, where it is greyish. The most remarkable departure from the type is the form shown at Plate V, fig. 6, which is from a specimen taken by Mr. Green on heather (*Calluna*, sp.). In this example alteration of form is due to compression by contact with the raised bark of the food-plant. The colour and texture of the puparium is also due, in a great measure, to the epidermal layer of the bark, beneath which the insect insinuates itself and makes the secretionary covering. The larval exuviæ are covered with a smooth, white secretion tinged with pale red, and without the central boss seen in the type.

Long. about 1 mm.

Male pupa (Pl. V, figs. 11—12) yellow, or pale orange yellow; antennæ, legs, wing-cases, and stylus

paler. Eyes and ocelli black; the latter elongate and placed close together.

Perfect male (Pl. V, fig. 8) varying from ochreous to pale orange yellow. Apodema black, shining. Legs dusky with long sparse hairs. Eyes and ocelli black. Abdomen gradually becoming paler towards the extremity. Antennæ of the same colour as the legs, having eight long clubbed hairs on the apical joint (Pl. V, fig. 9).

Larva.—Antennæ funiculate, of six joints; the first, second, third, and fourth shortest; fifth and sixth very long, transversely striate or ringed, and form a little more than two thirds of the entire length.

Habitat.—Cheshire, very common; Haslemere (Dr. Sharpe), Surrey; Lewisham (Douglas); Bearsted, Kent (Green); and Portarlington, Ireland.

Apparently an extremely local species, but where it occurs it is abundant and injurious.

The food-plants are:—plum, apple, pear, cherry, and currant. Mr. Green's examples were on heather (*Calluna*, sp.), which at the present time is the only wild, indigenous plant known to harbour this insect in Great Britain. It would seem, therefore, to have a decided preference for cultivated fruit trees in this country.

Distribution.—Widely distributed, and common in many parts of Europe, where it appears to be a very general feeder. Until quite recently it was not known to occur elsewhere; but Mr. Cockerell informs me he has received it from Alameda, California, on apple and pear. I should imagine, however, that it has been introduced into that country on cultivated plants; as the species has not been recorded elsewhere in the North American continent.

Habits.—Both male and female pass the winter in the second stage; and no apparent change takes place, in either sex, until the beginning of April. The second-stage males then pupate, and about three weeks after the pupal skin is thrown off and ejected at the posterior extremity of the scale, where it remains for a

short period. The appearance of the little shrivelled skin is a sure sign the perfect male will appear in a day or so. A fine sunny day brings them out almost directly after the moult, but cold retards their emergence. In 1896 the males were most abundant during the third week in April.

Shortly before the emergence of the males the females effect their final moult, and, although small, possess all the anatomical characters of the adults.

I have not observed the period of egg-laying or of the hatching of the larvæ. But this is very probably completed before the end of June, as the new scales are well formed by October, and the second stage of both sexes is then completed. The species is certainly not double-brooded in the open air in this country.

Explanation of the Plates.

Pl. V, fig. 1.—Puparium of adult female from currant (typical form). × 25.

Fig. 2.—Puparium of immature female from currant (typical form). × 25.

Fig. 3.—Puparium of adult female from peach, partly buried beneath the epidermal layer. × 25.

Fig. 4.—Puparium of immature female from peach. × 25.

Fig. 5.—Parasitised female, showing hole through which the parasite has escaped. × 35.

Fig. 6.—Puparium of male on *Calluna*, sp. × 25.

Fig. 7.—Puparium of male on peach. × 25.

Fig. 8.—Male. × 50.

Fig. 9.—Apical joint of male antennæ. × 600.

Fig. 10.—Tarsus and claw of male. × 600.

Fig. 11.—Male pupa, dorsal aspect. × 50.

Fig. 12.—Male pupa, ventral aspect. × 50.

Fig. 13.—Insects natural size *in situ* on branch of currant.

Fig. 14.—Insects natural size *in situ* on branch of

plum; many have been removed, leaving circular patches of white secretion.

Pl. VII, fig. 2.—Pygidium of adult female. × 250.

Pl. XII, fig. 1.—Margin of pygidium of adult female. × 600.

ASPIDIOTUS FICUS (Riley MS.).

(Pl. I, figs. 7—14; Pl. II, fig. 2; Pl. XI, fig. 2.)

Chrysomphalus ficus (Riley MS.), Ashmead, American Ent., 1880, p. 267.

Aspidiotus ficus, Comstock, Canad. Ent., vol. xiii, p. 8.

Chrysomphalus ficus, Berlese, Le Coccinigliе Italiane. Parte iii, 1895—6, p. 241.

Puparium of the female (Pl. I, figs. 7, 14) circular, moderately convex. Dark madder brown, purplish black, or reddish brown, paler towards the margin, where it is sometimes greyish or white. Exuviæ central; that of the larva dark orange brown or bright golden yellow, presenting a metallic appearance or lustre; secretionary covering circular and nipple-shaped; central portion white, but it is almost invariably wanting in the old examples; second exuviæ completely hidden beneath the secretionary covering, which forms a more or less flat, dark, purplish-brown zone, concentric with the first exuviæ. Ventral scale obsolete in the old examples; but in the young adults there is an extremely thin secretion on the tissues of the food-plant. Young scales are circular (Pl. I, fig. 8) and reddish brown; they are frequently superposed upon the scale of the female (fig. 7).

Diam. 1—2·25 mm.

Adult female (Pl. I, fig. 10) ovate, narrowed, and produced behind. Yellow with the pygidium pale orange towards the base. Body shrivelling at gesta-

tion (Pl. I, fig. 9); the thoracic segments converging towards the apex of the pygidium. Rudimentary antennæ with a short spine; and there are two similar spines on the margin in front. Rostrum extending a little beyond the second pair of spiracles. Thorax with a short spine (Pl. I, fig. 11), which does not appear very highly chitinised, and often disappears in the process of mounting. Free penultimate segment of abdomen, with a group of 8—9 tubular spinnerets connected on the dorsal surface with the same number of elongated pores. Pygidium (Pl. II, fig. 2) very large, with four groups of circumgenital glands; upper lateral groups of 4—8; lower laterals of 2—4. Dorsal tubular spinnerets slender, very long, some of them extending into the last free abdominal segment; the connecting dorsal pores are arranged in two double, subdorsal rows, and number about 15—18 in each group. There are four basal scars, equidistant, and transversely placed. Anus about twice its length within the margin. Vaginal opening a little beyond the centre. Margin (Pl. XI, fig. 2) with three pairs of well-developed subequal lobes, each emarginate or notched on its outer lateral margin. There are two plates between the first and second lobes; three between the second and third; and three beyond. The first six are similar, and have a deep sharp fringe; the seventh irregular, furcate, and broad at the base; the three last similar, each with a deep central cleft, the inner portion either simple and spine-like, or with one or more irregular serrations; anterior half with a deep blunt fringe. Beyond the latter the margin is very finely serrate, and has a single projecting spine.

Immediately within the margin are ten club-shaped glands, arranged in irregular pairs, each, with the exception of the fourth, connected with minute pores on either side, at the base of each lobe. Each lobe is followed by a short spine, and there is one arising from the centre of the base of the second and third lobes.

Scale of the male (Pl. I, fig. 12) short, ovate; sides

parallel, ends widely and equally rounded. Colour as in the female, with the posterior extension blue grey. Ventral surface (fig. 13) grey at the margin, becoming darker towards the centre, where it is usually pale blue. Larval exuviæ circular and pale orange yellow.

Long. ·75—1 mm.

Pupa mottled and streaked with dull orange; sheaths of the appendages colourless; eyes black.

Perfect male not observed in this country. Comstock describes its colour as orange yellow, with dark-brown apodema, and purplish-black eyes.

Habitat.—Royal Gardens, Kew; on *Garcinia cambogia* (Green); *Lonchocarpus barteri*, Benth.; *Eugenia malaccensis*; and *Phemieria incarnata.*

Distribution.—Abundant in the United States of America and the West Indies. Mr. Green has met with it in Ceylon. It is common in Australia, and I have received it on *Jambosa vulgaris* from Egypt (Prof. Sickenberger). In Europe Prof. Berlese has taken it in Italy.

From what I could gather at Kew this species does not increase very rapidly, but, judging from the various stages of the insect, several broods are probably produced during the year. My specimens were taken in July, and at that time the male scales were tenanted with mature pupæ. English examples are very dark, and in this respect most like those from Egypt.

Explanation of the Plates.

Pl. I, fig. 7.—Puparium of adult female, dorsal view, with a very young example superposed at side. × 25.

Fig. 8.—Puparium of immature female. × 25.

Fig. 9.—Adult female at period of parturition. × 25.

Fig. 10.—Adult female after treatment with potash. × 50.

Fig. 11.—Thoracic spine of adult female. × 600.

Fig. 12.—Puparium of male, dorsal view. × 25.
Fig. 13.—Puparium of male, ventral view. × 25.
Fig. 14.—Insects natural size *in situ* on leaf of food-plant.
Pl. II, fig. 2.—Pygidium of adult female. × 250.
Pl. XI, fig. 2.—Margin of pygidium of adult female. × 600.

ASPIDIOTUS DICTYOSPERMI (Morgan), var. ARECÆ, (Newstead).

(Pl. IX, figs. 7—11; Pl. II, fig. 3; Pl. XII, fig. 6.)

Aspidiotus dictyospermi, Morgan, var. *Arecæ*, Newstead, Ent. Mo. Mag., 1893; S.S., vol. iv, p. 185, pl. iv, fig. 2.

Puparium of the female (Pl. IX, figs. 7 and 8) circular, or approximately so; surface smooth or of the same texture as the surface of the leaf owing to the admixture of the epidermal tissues of the plant; central area convex; margin broadly flat. Colour usually rich orange brown, but sometimes ochreous brown or dark castaneous. Exuviæ central; those of the larvæ golden brown, having a somewhat shining, metallic appearance; those of the female much paler; first secretionary covering, with a central boss and concentric ring; the second flat, or with an outer raised, concentric ring. Under side of scale (Pl. IX, fig. 9) greyish; exuviæ highly polished. Ventral scale a thin secretion upon the plant.

Diam. 1—1·25 mm.

Adult female (Pl. IX, fig. 10) pyriform, pygidium large, with the apex somewhat angular; cephalic area slightly constricted; free abdominal segments distinct. Colour pale yellow, sometimes with a faint reddish tinge; pygidium with six perpendicular brown lines,

extending from the base of each lobe. Rudimentary antennæ with a very long straight spine. Margin of thoracic, and free abdominal segments with a few spiny hairs. Rostral filaments, about three times the length of the mentum. Pygidium (Pl. II, fig. 3) with four widely separated groups of circumgenital glands; the anterior laterals of 3—4; the posterior laterals 2—3. Subdorsal groups of tubular spinnerets slender (unless completely restored by boiling in potash they appear quite filiform), the longest reaching almost to the articulation of the segment; connecting dorsal pores in a short series of about four, and several smaller ones scattered towards the margin; there is also a long, central, tubular spinneret connected with a marginal pore between the median lobes. Vaginal opening midway between the circumgenital glands. Anal opening towards the margin. Margin of pygidium (Pl. XII, fig. 6) with three pairs of well-developed, subequal lobes; each lobe with the inner lateral margin entire, and curved outwards; the outer lateral margin with a deep notch, giving them a bilobed appearance. The median and second pairs of plates short, and fringed; the three between the second and third lobes of the same structure and length; there are from three to five beyond the third lobe; the first, when present, simple and pointed; the second and third constricted in the centre, forming a long, spear-shaped, pendulous, projection; margin of basal portion sharply serrate; the fourth plate is either of a similar structure to the latter, or is deeply divided and simple, with the outer margin long, and finely serrate; margin beyond finely serrate and with several dentitions, widely apart. Within the margin are five pairs of large club-shaped glands; each pair connected with the margin between the lobes. The spines are minute and placed a little in front of the lobes.

As the embryo larvæ are well formed within the body of the parent I presume the females are oviviparous.

Scale of the male circular, with the exuviæ central; secretional covering nipple-shaped. Colour as in the female scale.

Diam. ·80 mm.

Perfect male unknown.

Habitat (under glass.)—In Cheshire, on *Areca*, sp., *Cypripedium*, spp., *Dendrobium*, spp., and *Anthurium*, sp. On *Aroids*, Bot. Gard., Dublin (Burbidge); on *Aloe zeyheri*, from Durban; Bot. Gard., Cambridge (Lynch); on *Cœlogyne*, ? London (Douglas); and sparingly on *Areca*, sp., Royal Gard., Kew; quite recently I have also received it on various palms from Raby Castle, Darlington, Durham (Brock).

Distribution.—Mr. Morgan's types were from Demerara; it has also been recorded from Brazil and the West Indies.

I have never met with typical examples of *A. dictyospermi*, the puparia of which Mr. Morgan describes as "greyish-white, with exuviæ in the centre, depressed, of an elongate oval shape, about 1·2 mm. longest diameter. The centre of the larval skin is of a dark orange colour, whilst the exuviæ are of a light yellow." *

Explanation of the Plates.

Pl. IX, fig. 7.—Puparium of adult female with large concentric ring, indicating extent of second exuviæ; and with a young puparium superimposed at margin. × 25.

Fig. 8.—Puparium of adult female without large concentric ring, showing structural character of surface caused by epidermal layer of plant tissues. × 25.

Fig. 9.—Puparium of young adult female, ventral view, showing position of larval and second exuviæ. × 30.

Fig. 10.—Adult female at period of gestation. × 40.

Fig. 11.—Insects natural size *in situ* on portion of leaf of *Cœlogyne*.

* 'Ent. Mo. Mag.,' 1889, xxvi, p. 352, pl. v, figs. 3 and 5.

Pl. II, fig. 3.—Pygidium of adult female. × 250.
Pl. XII, fig. 6.—Margin of pygidium of adult female. × 600.

ASPIDIOTUS ALIENUS (Newstead).

(Figs. 13, 14.)

Aspidiotus alienus, Newst., Ent. Mo. Mag., S.S., vol. xii, p. 81, 1901.

Female puparium, subcircular, or irregular ovate, flat, convex; colour pale purple brown, margins paler. Larval exuviæ shining black, secretionary covering dull brown, forming a central point, and concentric ring above the rest. Underside brighter purple brown, gradually darkening towards apex, which is usually mealy. Ventral scale rather stout, and generally remains attached to the food-plant.

Greatest diameter 2—2·25 mm.

♀ adult pyriform. Rudimentary antennæ tuberculate, with a basal, curved, spiny hair. Parastigmatic glands absent. Pygidium (figs. 13, 14) rather pointed; lobes in three pairs, of which the median pair are sometimes slightly the longest, the third, broadest, have the margins sloping upwards. Beyond the last lobe the margin is produced into three to four (usually three) equidistant, angular processes, with the margin between them finely crenulated. The plates between the lobes broadly bifurcate; there is also a larger divided plate at the base of the first angular process, and a single short spine-like one at the base of each of the other angular processes. There are two exceedingly fine spines between the third lobe and the plate succeeding it, and a much larger one in the centre of the margin. Circumgenital glands in four groups. Anterior laterals from eight to nine, posterior laterals seven to nine. Club-shaped thickenings of the body-

wall in six pairs, the central, third, and fourth pairs being less than half the length of the others. Margin between the last club-shaped thickening and the long marginal hair beyond it highly and broadly chitinised,

FIG. 13.

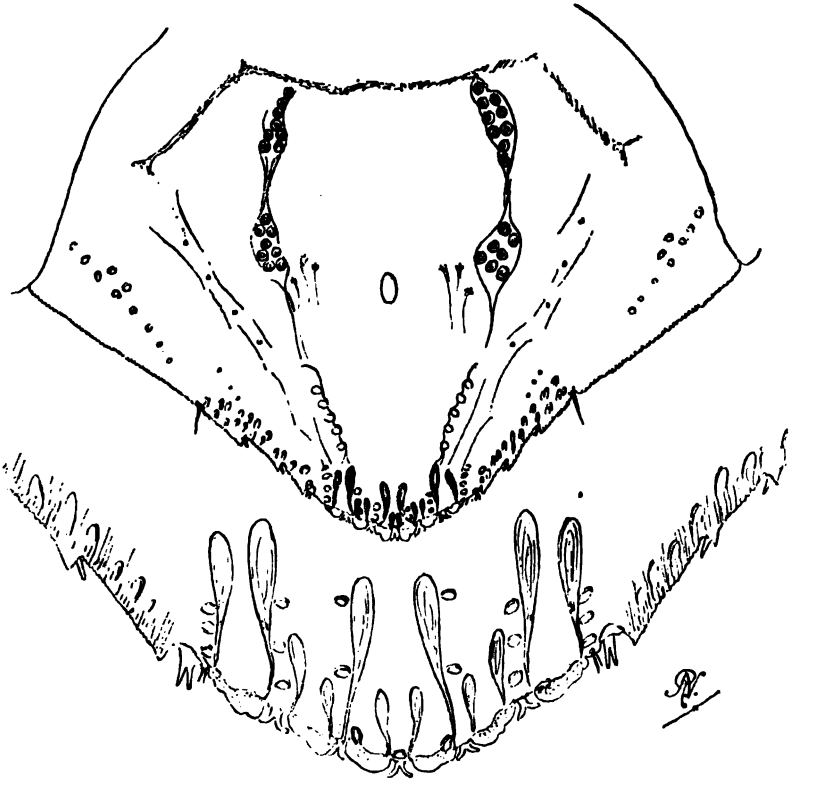

FIG. 14.

FIG. 13.—*Aspidiotus alienus*, pygidium of adult, ♀. × 250.
FIG. 14.—Margin of pygidium. × 600.

the inner margin being defined by a series of gland-like markings. Dorsal tubular spinnerets in a single series, about seven in number, arising between the fourth and fifth club-shaped thickenings; and there is

a series of ten to twelve smaller pores within the margin beyond the central spine. Vaginal opening central. Dermis with many long spiny hairs on the cephalic area.

Larva.—Antennæ funiculate, of six joints, the funicle forming one half of the entire length.

Habitat.—On *Cattleya Skinneri*, under glass, London. Collected by Mr. E. E. Green, to whom I am indebted for the specimens.

Distribution.—Probably a subtropical species.

The form of the puparia, and also the deeply serrated margin of the pygidium, somewhat resembles *Aspidiotus biformis*, Ckll., but it is much more closely related to *A. scutiformis*, Ckll., and *A. Bowei*, Ckll. It differs from either of these latter, however, by the unusually broadly divergent bifurcate plates, and the regular and deeply serrated margin, which latter character resembles the serrations in *A. paulistus*, Hempel.

ASPIDIOTUS PERSEÆ (COMSTOCK).

(Pl. XI, fig. 7, after Comstock.)

Aspidiotus perseæ, Comstock; Report, 1880, p. 305, pl. xii, fig. 3; pl. xiii, fig. 3.

Chrysomphalus perseæ, Leonardi; Monogr. del genere Aspidiotus. Nota preventiva, Estr. Riv. Patol. Veg., Anno V, 1896—7, p. 286.

Puparium of the female flat, convex; colour dark reddish brown, or purplish brown. Exuviæ approximately central; intense black; first secretional covering nipple-shaped, the second slightly convex, or taking the same contour as the scale; colour of both dull ochreous grey.

Diam. 1·50—2 mm.

Having only seen the puparia of this insect from the collection of Mr. Douglas, I have no alternative but

to quote Prof. Comstock's original diagnosis of the female.

He says: "The colour of the female is orange. The body is nearly as wide as long. The last segment presents the following characters: there are four groups of *spinnerets; the anterior laterals consist of from ten to twelve, and the posterior laterals of about eight.

"There are three pairs of well-developed *lobes* present; each lobe is wider than long; the first lobe of each side is the smallest, the third the largest; the second is usually notched; the third is serrate.

"The posterior half of the *lateral margin of the segment* appears to be of the same structure as the lobes; it is serrate, and usually more or less deeply notched four or five times.

"The body-wall is furnished with seven *thickenings* on each side of the meson. These thickenings are long, somewhat club-shaped, the anterior part being enlarged and rounded. There is one terminating at the base of each margin of each lobe. Those ending at the base of the lateral margins of the lobes are much longer than the others. The seventh thickening terminates between the second and third lobes, and is narrow and inconspicuous.

"The *plates* are small, inconspicuous, and irregularly toothed. There are two between each pair of lobes, and between the third lobe of each side and the posterior lobe of the thickened lateral margin. * * * * * * *

"On the ventral side there are four pairs of *spines*, there being a spine at the base of the lateral margin of each lobe, and one at the anterior end of the thickened part of the lateral margin of the segment. On the dorsal side there are only three pairs of spines, there being none on the first lobes. Those of the second and third lobes are situated near the middle of the bases of the lobes; the third spine is nearly opposite the fourth spine of the ventral surface."

Habitat.—On *Anthurium harrisii*, at the Royal

* Circumgenital glands.

Gardens, Kew. Was first recorded in 1889. Subsequently it has not been met with either at Kew or elsewhere in the British Isles.

It is a North American species, and was first described by Prof. Comstock from specimens on Red Bay (*Persea carolinensis*), collected in the United States.

My description of the scale of the female is from British specimens from the collection of Mr. J. W. Douglas. All my attempts to obtain British examples of the female have, so far, failed.

Puparium of the male elongate; colour like that of the female; exuviæ black and placed towards the anterior margin. Secretional covering as in the female.

Long. about 1 mm.

Explanation of the Plate.

Pl. XI, fig. 7.—Margin of pygidium of adult female after Comstock.

Aspidiotus spinosus (Comstock).

(Pl. X, fig. 3; Pl. XI, fig. 4.)

Aspidiotus spinosus, Comstock; Report, 1883, p. 70, fig. 7.

Aspidiotus cydoniæ (Comstock), Newstead; Ent. Mo. Mag., 1897, p. 74.

Evaspidiotus spinosus (Comstock), Leonardi; Gen. e sp. di Diaspiti. Est. dal. Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII], p. 83, fig. 24.

Puparium of the female high, convex, approximately circular; completely covered with the epidermal layer of woolly fibres of the food-plant. Exuviæ central, or

a little towards the anterior margin; those of the larvæ pale yellow and frequently exposed; secretionary covering so completely hidden by the woolly fibres as to obscure both form and colour. Ventral surface of scale pale ochreous or greyish ochreous. Ventral scale adhering to plant is moderately thick, and dusky white. Prof. Comstock (*l. c.*) describes the colour of the scale as "very light brown or dirty white."

Diam. 1—1·75 mm.

Adult female pyriform. Pygidium (Pl. X, fig. 3) rather short. Circumgenital glands in four groups; the anterior laterals from three to six, the posterior laterals from three to six; they are more or less continuous, and arranged in a single series. Vaginal opening opposite the centre of the grouped glands. Anal opening very small, and placed quite near to the margin. Subdorsal groups of tubular spinnerets, moderately long, are connected with a few comparatively small dorsal pores. Margin of pygidium (Pl. XI, fig. 4) with the median lobes well developed, and slightly convergent; margins straight, with slight notch at the distal extremity. Second and third pairs of lobes small, sometimes quite rudimentary. The median plates are simple and spine-like; the pair between the median and second lobes deeply and strongly fringed; there are usually two between the second and third lobes, deeply and irregularly fringed, and either more or less palmate, or shaped somewhat in the form of a table fork; there are from five to seven beyond the third lobe, each deeply divided in one or two places, with the outer lateral margins strongly but irregularly serrate.

The spines are remarkable for their great size. The first is shortest, and placed *over* the anterior lateral portion of the median lobes, and, in my examples, never extend beyond the latter; the second and third dorsal spines are placed immediately opposite, and extend beyond the second and third lobes respectively; that over the second lobe is much the largest, and is

very broad and flat; the fourth spine follows closely the last marginal plate; the fifth spine is isolated and some considerable distance beyond the fourth. Those spines on the ventral surface are shorter and much more slender than those on the dorsal surface; there is one opposite each of the second, third, and fourth dorsal spines, or a little anterior to them. There is a narrow, but decided, cleft in the margin between the median and second pairs of lobes.

The male is apparently unknown in any stage.

Habitat.—The Royal Gardens, Kew, is the only known locality for this interesting species. It occurred in great numbers on the huge dead leaf-stalks of the magnificent and long established specimen of *Arenga saccharifera*, from the Malay archipelago. Every insect was dead; and, judging from the mouldy appearance of the scales, the insects had died long since. Quite 50 per cent. were parasitised, which is remarkable, as the Coccids found in this country upon stove and greenhouse plants are rarely attacked by insect parasites. I remember one other instance, and that was an extensive colony of *A. hederæ*, which were perfectly riddled by a wandering larva of a small species of Diptera.

It is probably a Palæarctic insect; Professor Comstock's types were from the United States, and, excepting our British examples, it is not known to occur elsewhere. The species comes very near to *A. Camelliæ*, Sign., but the presence of grouped circumgenital glands easily distinguishes it from the latter. Moreover, the huge marginal spines easily separate it from all other species of Aspidiotus.

Explanation of the Plates.

Pl. X, fig. 3.—Pygidium of adult female. × 250.
Pl. XI, fig. 4.—Margin of adult female. × 600.

ASPIDIOTUS BRITANNICUS (Newstead).

(Pl. VIII, figs. 8—12; Pl. VII, fig. 3; Pl. XII, fig. 4.)

Aspidiotus hederæ, Newstead; Ent. Mo. Mag., S.S., p. 279, 1896; *nec* Vallot.

Aspidiotus britannicus, Newstead; Ent. Mo. Mag., S.S., vol. ix, p. 93, 1898.

Evaspidiotus britannicus (Newstead), Leonardi; Gen. e sp. di Diaspiti. Est. dal. Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII], p. 223.

Puparium of the adult female (Pl. VIII, figs. 8, 12), circular or approximately so; moderately convex. Colour dusky ochreous, with a broad, smoky brown central zone. Exuviæ central, or a little to one side; those of the larvæ dark yellow, or dull orange yellow; secretionary covering very thin, does not obscure either form or colour of the exuviæ. Second secretionary covering, smoky brown, entirely covers the exuviæ. Ventral scale very thin, remains attached to the leaf. The scales very readily fall from the food-plant on the slightest disturbance of the contour of the leaf.

Diam. 1·75—2 mm.

Puparium of the female second stage (Pl. VIII, fig. 9), on underside of leaf, fulvous, with the larval exuviæ bright ochreous yellow, margins darker. In exposed situations on the leaves or branches the puparia are smoky brown with orange-ochreous exuviæ.

Adult female (Pl. VIII, fig. 10) translucent yellow; short ovate; with the segmentation very distinct; the pygidium well defined and produced.

Pygidium (Pl. VII, fig. 3) with four or five groups of circumgenital glands; the anterior group, rarely present, consists of 2 to 3; the anterior laterals from 7 to 10; the posterior laterals 7 to 8; the lateral groups in a narrow, more or less continuous series.

Vaginal opening a little in front of the centre. Anal opening midway between the former and the apex. The groups of tubular spinnerets long; the longest extending almost to the base of the pygidium; connecting pores, towards the margin, occur on both dorsal and ventral surface. Margin of pygidium (Pl. XII, fig. 4) with three pairs of well-developed and widely separated lobes; the median and second pairs, subequal, are notched or emarginate at the distal extremity of the margins, giving them a decided trilobed appearance; the third pair, smallest, usually have the inner lateral margins complete, the outer lateral margin with a notch at the extremity, or the hind margin irregularly notched. Plates comparatively short; median, second, and third pairs narrow, with one to three apical divisions; the first beyond the third lobe is also narrow, and serrated on its outer lateral margin; the two next very broad, have a deep central cleft; the posterior half simple or with a divided apex, the anterior half strongly serrate on the outer lateral margin; the last plate is generally short and serrated in the same way as the previous ones. Two spines only were observed, the first opposite the third lobe, the second beyond the fringe; others probably exist, but my specimens were much too badly infested with fungi to ascertain this.

Puparium of the male (Pl. VIII, fig. 11) similar to that of the second-stage female; more or less circular, contracted forms elongate or widely ovate. Colour bright pale fulvous. Larval exuviæ central, usually bright orange-ochreous; secretionary covering thin, smooth, and transparent, so that the colour of the sublying exuviæ shows through. The above description applies to such specimens as one finds upon the under sides of the leaves; those found in exposed situations are much darker, and often partly covered with a sooty deposit.

Diameter 1 mm.

Habitat.—On holly (*Ilex spp.*) at Teddington, near

London (Dr. Masters), and the Royal Botanic Gardens, Kew (Nicholson). It also occurs at Kew on *Ruscus hypoglossum*.

It was first discovered at the former locality in November, 1896, infesting a holly fence, and occurred in such swarms as to seriously injure the shrubs. Measures were taken to destroy the insects by the application of a paraffin emulsion, which effectually killed the greater number of the insects on the upper surfaces of the leaves; but nearly all those on the under sides had escaped the application.

The apparent limited distribution of this insect is very remarkable. In all probability it awaits the hunter in other parts of the British Isles, but all attempts at its discovery elsewhere have so far failed.

I must here acknowledge my indebtedness to Dr. Maxwell T. Masters, the Editor Gardeners' Chronicle, and Mr. R. McLachlan, for the kindly interest taken in procuring a liberal supply of specimens; and all the more for adding so interesting a species to our fauna.

Distribution.—Mr. Cockerell informs me he has recently met with it in the United States; but I doubt if it is indigenous to that country.

Description of the Plates.

Pl. VIII, fig. 8.—Puparium of adult female. × 25.
Fig. 9.—Puparia of immature female. × 25.
Fig. 10.—Adult female. × 25.
Fig. 11.—Puparium of male. × 25.
Fig. 12.—Insects natural size *in situ* on holly leaf.
Pl. VII, fig. 3.—Pygidium of adult female. × 250.
Pl. XII, fig. 4.—Margin of pygidium of adult female. × 600.

ASPIDIOTUS HEDERÆ, Vallot.

(Pl. VIII, figs. 1—7; Pl. X, figs. 1, 1 *a*; Pl. XII, fig. 3.)

Chermes hederæ, Vallot; Mém. Acad. Dijon (1829).
Aspidiotus nerii, Bouché; Schadl. Gart. Ins., 1833—52.
Aspidiotus palmarum, Bouché; Naturg. Ins. (1834), 1, 17, 5.
Aspidiotus palmatum, Blanch; Hist. Nat. (1840), iii, 215.
Aspidiotus genistæ, Westwood; Synop. Gen. Brit. Insects (1840), 118.
Aspidiotus epidendri, Bouché; Ent. Zeit. Stett. (1844), p. 293.
Diaspis obliquus, Costa; Faun. Nap. 21, 2, pl. vi, figs. 6—13, 13.
Chermes ericæ, Boisduval; Ent. Hortic. (1867), 327, 330.
Diaspis Bouchéi, Targioni-Tozzetti; Studi sulle Coccin. (1867).
Aspidiotus alöes, Boisduval; Ent. Hort. (1867), p. 329.
Aspidiotus budleiæ, Signoret; Ann. de la Soc. Ent. de France, 1868, p. 115. Essai, p. 89.
Aspidiotus lentisci, Signoret; Essai, p. 439.
Aspidiotus ulicis, Signoret; Essai, p. 97.
Aspidiotus ceratoniæ, Signoret; Essai, p. 92, pl. iv, fig. 2.
Aspidiotus cycadicola (Boisduval), Signoret; Essai, p. 93.
Aspidiotus gnidii, Signoret; Essai, p. 96.
Aspidiotus ilicis, Signoret; Essai, p. 97, pl. iv, figs. 3, 3*a*.
Aspidiotus myricinæ, Signoret; Essai, p. 99, pl. iii, fig. 10.
Aspidiotus limonii, Signoret; Essai, p. 99.

Aspidiotus ulicis, Signoret; Essai, p. 106.
Aspidiotus villosus, Targioni-Tozzetti; Catal. (1869), p. 45, esp. 6.
Aspidiotus vriesciæ, Signoret; Essai, p. 108.
Aspidiotus corinocarpi, ? Colvé; Estudios sobre algunos insectos de la familia de los Coccidos (Impr. de Nicasio Ruis, Monfort), Valentia, 1881, p. 39.
Aspidiotus carpodeti, Maskell; Trans. N.Z. Inst., 1884, vol. xvii, p. 21. Scale Insects N.Z., 1887, p. 41.
Diaspidiotus villosus (T. T.), Cockerell; the San José Scale, pp. 18, 19.
Evaspidiotus hederæ (Vallot), Leonardi; Gen. e sp. di Diaspiti. Est. dal. Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII], p. 98.

Puparium of old adult female (Pl. VIII, fig. 1) approximately circular, or ovate; outline often irregular; flat, convex. Colour dull ochreous, margins paler. Exuviæ central, yellow; secretionary covering smooth, very thin, does not totally obscure the sublying exuviæ; it soon disappears, however, and the exuviæ are usually naked.

Puparium of the young adult female (Pl. VIII, fig. 2) pure opaque white. Exuviæ, varying from very pale yellow to bright orange, are usually exposed.

Diam. 1—2 mm.

Adult female (Pl. VIII, fig. 3) pyriform, attenuated posteriorly; free abdominal segments distinct. Colour pale yellow; pygidium a little reddish towards the apex. At the period of gestation the body becomes swollen, and almost all trace of articulation disappears; after parturition it shrivels and becomes a shapeless mass. Rostral filaments short. Free abdominal segments with large tubular spinnerets connected with large oval-shaped pores at the margin. Spiracles (Pl. X, fig. 1*a*) large, cylindric; sides finely reticulate. Pygidium (Pl. X, fig. 1) with four groups of circum-

genital glands; the anterior laterals of from 8—13; and the posterior laterals from 5—10. The groups are well separated; but sometimes an odd gland or two may be found isolated from the rest. Vaginal opening near the centre of the grouped glands. Anal opening considerably below them. Subdorsal groups of tubular spinnerets short, cylindrical; connecting pores, widely divergent, form a broad irregular band, extending the entire length of the pygidium. There are also a series of about seven, short, cylindric, tubular spinnerets on either side of the median lobes; another of the same structure arising between them; and immediately outside each a singular spinneret very much attenuated posteriorly. Margin of pygidium (Pl. XII, fig. 3) with three pairs of lobes; the median pair are well developed, rather widely separated, have the inner lateral margins slightly curved, entire, or faintly notched; the second and third pairs very variable. Usually the former are well developed, rectangular and entire, or notched on the outer lateral margin; the third pair similar in structure, but much smaller, and often rudimentary. The variation in the lobes is probably due to the age of the insects. The spines are very long, but being semi-erect do not usually appear so. The first is placed at the base of the outer margin of the median lobes; the four next are arranged in pairs, one dorsal and one ventral, opposite the second and third lobes; the sixth opposite the last two or three plates, on the dorsal surface; the seventh just beyond them. Plates very long and deeply fringed; the median pair shortest; those between the first and second lobes a little longer and of a similar structure; of the three between the second and third lobes the first is narrowest, the other two are deeply and irregularly fringed on the outer lateral margins; as also are the remaining five or six beyond the third lobe.

Puparium of the male pure white (Pl. VIII, fig. 5); usually ovate; but the form is inconstant and varied.

Exuviæ central or approximately so; are usually naked, and vary from pale to bright orange yellow.

Perfect male pale yellow mottled with dull purplish brown, or reddish brown; apodema brighter.

Eggs and larvæ pale yellow.

Habitat.—Under glass; occurring throughout the British Isles as a common greenhouse pest, infesting many kinds of plants. The following is a list of the principal food-plants:—Various species of palms, *Agave*, spp., *Erica*, spp., *Passiflora*, spp., *Tacsonia*, sp., *Dracæna*, sp., *Aucuba*, sp., *Azalea*, sp., *Aristea major*, *Lardizabala*, sp.

Distribution.—It is found abundantly in the open air in the South of Europe, North Africa, United States of America, Australia, and New Zealand; is apparently Cosmopolitan and almost omnivorous.

This species is given to a great amount of variation in the colour, texture, and substance of the puparium, which in a great measure, no doubt, accounts for the long list of synonyms. Specimens from Aloe received from various countries have very dense puparia, and, although at first pure white, eventually become dull opaque straw colour. Again, the examples on imported lemons have the puparium very thin and flat, much more so than the examples on Aloes, and are invariably accompanied by a green discoloration of the fruit (Pl. VIII, fig. 6). Specimens on palms in this country are also thin and semi-transparent, of a pale straw colour, and never opaque snow-white, as in typical examples.

The synonymy of the species is taken chiefly from Dr. Leonardi's excellent monograph, which is here gratefully acknowledged.

Explanation of the Plates.

Pl. VIII, fig. 1.—Puparium of adult female (dark form). × 25.

Fig. 2.—Puparium of early adult female. × 25.

Fig. 3.—Adult female before parturition. × 35.

Fig. 4.—Parasitised female, showing pupa of parasite within. × 25.
Fig. 5.—Puparium of male. × 25.
Fig. 6.—Insects natural size *in sitû* on rind of lemon.
Fig. 7.—Insects natural size *in sitû* on leaf of *Nerium oleander*.
Pl. X, fig. 1.—Pygidium of adult female. × 250.
Fig. 1*a*.—Spiracle of adult female. × 600.
Pl. XII, fig. 3.—Margin of pygidium of adult female. × 600.

Aspidiotus cyanophylli (Signoret).

(Pl. IX, figs. 1—6; Pl. X, fig. 2; Pl. XII, fig. 5.)

Aspidiotus cyanophylli, Signoret; Essai, p. 93, pl. iii, fig. 11.
Evaspidiotus cyanophyli (Signoret), Leonardi; Gen. e sp. di Diaspiti. Est. dal. Rivista di Patologia Vegetale, 1897 [VI], 1900 [VIII], p. 80.

Puparium of the female (Pl. IX, figs. 1, 2) at first more or less circular; but the old adults are ovate, or elongate ovate, with one extremity usually more narrowed than the other; the side next the midrib, or prominent vein of the leaf, compressed and straight; central area high convex; semitransparent, the yellow colour of the sublying female, the eggs and the effete skins showing through the puparia. At first the puparia are almost colourless; but the old dried examples become straw coloured or pale ochreous (fig. 2). Exuviæ central or nearly so, pale yellow or colourless; secretional coverings transparent; the first ovate is either smooth or has a central prominence; the second is either elongate or widely ovate and smooth.

Typical examples. Long. 1—2 mm.
Var. on Aralia. Long. 2—3 mm.

Female adult (Pl. IX, figs. 4 and 5) either widely ovate, or very elongate and attenuated posteriorly. The former may be considered typical; the latter a remarkable elongated variety. Colour bright yellow; with apex of pygidium a little reddish.

Anterior margin with several long slender hairs. Rudimentary antennæ with a long, usually curved spine. No pores or glands on free abdominal segments. Spiracles reticulated as in *A. hederæ*. Pygidium (Pl. X, fig. 2) with four groups of circumgenital glands; the anterior laterals consist of three or four; the posterior laterals of three to five; both groups forming an irregular, single series; the formula of five examples are given below:

3—3	4—3	4—3	4—4	3—3
3—3	4—4	3—3	4—4	4—5

Vaginal opening opposite the anterior extremity of the circumgenital glands. Anal opening very large, midway between the posterior extremity of the glands and the margin. Subdorsal groups of tubular spinnerets long and stout; there are about four connected with a corresponding number of large dorsal pores; a central group, usually numbering about three, is connected with marginal pores. Margin of pygidium (Pl. XII, fig. 5) with the median pair of lobes well developed, and usually trilobate; second and third pairs much smaller, and pointed; the third pair often quite rudimentary. Plates long and deeply fringed; median and second pairs similar; the three between the second and third lobes sometimes with fine lateral serrations; there are usually three beyond the third lobe, very deeply divided, and strongly furcate, or branched; not deeply and sharply ciliated as the corresponding plate in *A. hederæ*. There is a spine at the base of each lobe, on the outer lateral margin; and a pair beyond the plates, one dorsal, the other ventral. Body-wall with three deep marginal notches, or incisions, on each side of the median lobes.

Puparium of the male (Pl. IX, fig. 3) circular, with a slight posterior extension. Exuviæ approximately central; secretional covering with a central boss and concentric ring. Colour dull ochreous.

Eggs and larvæ yellow, or greenish yellow.

Habitat.—I have met with this species in Cheshire only in two localities. At Eaton it occurred very sparingly upon palms and orchids; at Upton abundantly on two or three species of *Aralia* and *Ipomœa*, sp.; from Dublin (Burbidge) I have it on *Cycas revoluta*. It does not appear to have extended its distribution in this country, but is a persistent pest, and when once established will continue for years upon the same plants.

Signoret's types were from a colony found in the Luxembourg Gardens on *Cyanophyllum magnificum*, a Venezuelan plant. Professor Comstock has met with the species in the United States on various species of *Ficus*. Mr. Green records it from Ceylon on tea, cinchona, and palm plants.

Explanation of the Plates.

Pl. IX, fig. 1.—Puparium of adult female. × 25.

Fig. 2.—Puparium of adult female (old opaque form). × 25.

Fig. 3.—Puparium of the male. × 25.

Fig. 4.—Adult female, ovate form, at period of gestation. × 40.

Fig. 4*a*.—Adult female, ovate form, after parturition. × 40.

Fig. 5.—Adult female, elongate form, before parturition, from *Aralia*. × 40.

Fig. 6.—Insects natural size on portion of palm leaf.

Pl. X, fig. 2.—Pygidium of adult female. × 250.

Pl. XII, fig. 5.—Margin of pygidium of adult female. × 600.

ASPIDIOTUS ARTICULATUS (Morgan).

(Figs. 15, 16.)

Aspidiotus articulatus, Morgan; Ent. Mo. Mag., vol. xxv, pl. v, fig. 5, p. 352.

Selenaspidus articulatus (Morgan), Cockerell; U.S. Dept. of Agriculture; Div. of Ent. Technical Series, No. 6, Washington, 1897, p. 23.

Selenaspis articulatus (Morgan), Leonardi; Est. dal. Rivista di Patologia Veg., 1897 [VI], 1900 [VIII], p. 37, fig. 9.

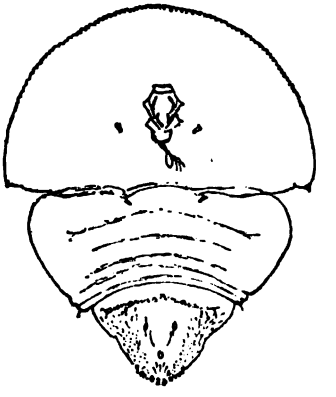

FIG. 15.—*Aspidiotus articulatus* ♀. × 40.

Puparium of female semitransparent, pale brown, or yellowish brown, margins paler; flat, approximately circular. Exuviæ central or subcentral, yellow; the circumference of the second exuviæ forming a depression. Old examples become greyer, but the central area over the exuviæ usually remains orange brown or yellowish.

Diameter 2—2·25 mm.

Adult female (Fig. 15) viviparous; pyriform, "with

a marked division between the thoracic and abdominal regions" (Morgan); cephalic and thoracic area forming a section of a hemisphere, margin finely crenulated in front, posterior angles with one or two minute spine-like processes. Rudimentary antennæ with a single fine-curved hair. Rostrum with central filaments very short. Spiracles, simple tubular organs, upper pair

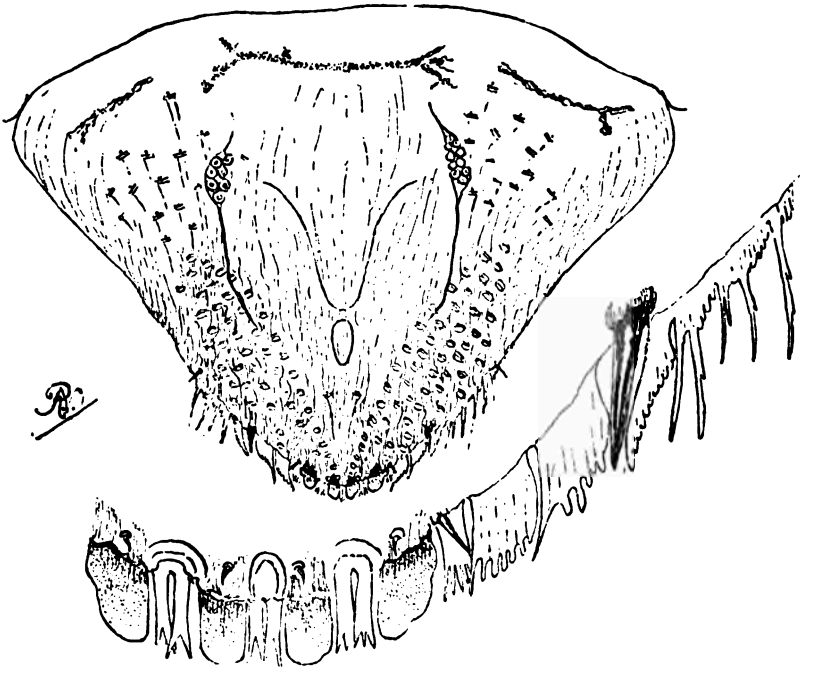

FIG. 16.—*Aspidiotus articulatus*, pygidium of adult ♀. × 250.

opposite the rostrum, lower pair on the abdominal segment near its articulation with the thorax.

Pygidium (Fig. 16) narrowly rounded. Median pair of lobes more or less rectangular, outer margin usually faintly notched; second pair largest, margin sloping upwards, and notched towards the base of the outer margin, or sometimes bidentate. The single pair of

plates between each of the lobes are usually bifurcate, and not extending beyond the lobes; beyond the second pair of lobes are three palmate plates, the first very small, the other two much larger than the lobes. Immediately above these is a very conspicuous spiny process, and anterior to the latter are four to five more plates, the first broadest and serrate all along its outer margin, the others are usually deeply divided. Dorsal tubular spinnerets occupying a broad area along the margins; and numbering about fifty-five on either side. A single minute spine is situate at the base of each lobe, a larger one over the first palmate plate, and a similar one near the base of the last plate. Circumgenital glands in two lateral groups consisting of six to eight spinnerets.

The female of the second stage shows no signs of the articulation which forms so marked a feature in the adult insect.

Habitat.—On *Ixora coccinea*, under glass, Worcester Park, Surrey, collected by Mr. E. E. Green, June, 1899.

Distribution.—This curiously distinct species is of tropical origin. Mr. Morgan's types were from Demerara (Coll. Douglas), on *Dictyospermum album.* Hempel also records it from Brazil, and Cockerell from Mexico. It is one of the commonest species of Coccids in the West Indies, where it infests palms and various other plants. It has also been found in the southern states of America, and is generally known as the "West Indian Red Scale." It does not appear to have got much hold in this country as a greenhouse pest, but may in time spread, and every precaution should be taken to prevent its doing so.

Gymnaspis (Newstead).

The adult female puparium of this genus is without larval exuviæ or secretion, and is composed *entirely* of the naked moulted skin of the second-stage female. Up to the second stage of its existence it resembles that of a *Diaspis* in having larval exuviæ, and a broad secretionary margin, which completely covers the soft tumid body of the female up to the penultimate period of its life (Pl. XXXIV, fig. 10). The dermis then begins to harden at the margins, and eventually becomes highly chitinised and opaque, which character extends over the dorsal and ventral parts. During this process the insect becomes highly convex, and the whole of the puparium is cast off, leaving the insect perfectly nude (Pl. XXXIV, figs. 1—3). The final change is effected in the same way as in *Aonidia* and *Fiorinia*, and, like the members of these genera, the adult female remains hermetically entombed in the skin of the previous moult in which she apparently brings forth her young alive. In the numerous specimens examined I found no trace of eggs, but frequently a single larva fully formed, but very sluggish, and remarkable for its great size. The absence of circumgenital glands also suggests a viviparous habit. How the larvæ escape from the thick walls of the puparium is a mystery, but this is probably effected through the anal opening on the dorsal area; but this orifice is so minute as to be only visible to the high power of the microscope.

The puparium of the male resembles those of certain species of *Aspidiotus* (*ficus*, *personatus*, etc.), but the larval exuviæ is much larger.

GYMNASPIS ÆCHMEÆ (Newstead).

(Pl. XXXIV, figs. 1—15.)

Gymnaspis æchmeæ, Newstead; Entomologist's Monthly Mag., second series, vol. ix, 1898, p. 92.

Female puparium (figs. 1—6) composed *entirely of* the naked moulted skin of the second-stage female. High convex, more or less circular, anal extremity attenuated; margins produced and convex, entire or constricted over the regions of the spiracles; the constrictions irregular and frequently asymmetrical; irregularly and widely punctate; shining black or bronzy black, opaque, and very thick; the ventral surface as much so as the dorsal. The ventral surface (figs. 5, 6) has a delicate white or ochreous-white secretion upon it which usually bears the impressions of the leaf structure, and sometimes projects beyond the margin of the puparium.

Diam. ·50—·90 mm.

Adult female (fig. 7) approximately circular, flat beneath, convex above; margins flat and thin, forming a flange except at the anal extremity. Colour dull purple or mauve, with dusky white margin. Rudimentary antennæ (fig. 9) usually with three blunt spines. Pygidium (fig. 8) without circumgenital glands. Vaginal opening and anus opposite; margin with a fringe of blunt tubercles, or extensions of the body-wall, and a few short spines. There are also a few very slender tubercles arising from the extreme margin.

Puparium of the second-stage female (fig. 10) purplish brown, circular, with a broad marginal secretion; larval exuviæ central, naked; black or bronzy black.

Diam. ·50 mm.

Male puparium (fig. 11) ovate, purplish brown, margins paler; exuviæ at the anterior extremity; shining black or bronzy black; ventral surface open, but there is a very thin secretion on the leaf.

Long. ·75 mm.

Perfect male unknown. All the scales I obtained were unfortunately untenanted.

Larva comparatively large (fig. 12), short, ovate; pale mauve; eyes black. Antennæ (fig. 13) of five joints; one, two, and three subequal, four a little longer than three; six very long and crenulated, forming half of the antennæ; there is a rather long hair on the second, two on the third, and one on the fourth joints; and the apical joint has a median and two apical hairs. The larvæ under observation were sluggish creatures, and when walking carried the antennæ and legs beneath the body.

Habitat (under glass).—On *Æchmea aquilega*, at the Royal Botanic Gardens, Kew. Discovered in 1898.

Superficially this species bears a striking resemblance to *Aspidiotus personatus*, Comst., but it is a trifle larger, and decidedly more glossy. At first I actually mistook it for the latter, and did not discover my error until examining it under the microscope. On a subsequent visit to Kew I found the species had considerably increased, and Mr. Nicholson informs me that it now occurs on other allied species of the *Bromeliaceæ*. It is evidently of pernicious habits, and, regardless of numerous "cleanings," still exists in large numbers.

Distribution.—Prof. Adolph Hempel * has recently recorded this species from Rio de Janeiro on cultivated plants ("nas folhas duma planta apparentemente cultivada"). It may therefore be indigenous to that or some other country with a similar climate.

* As *Coccidas Brazileiras*, 'Rivista do Museu Paulista,' vol. iv (1900), p. 508.

Description of the Plates.

Pl. XXXIV, figs. 1—3.—Puparia of adult female (dorsal). × 25.

Fig. 4.—Puparium of adult female (profile), with part of puparium (hardened skin of the second-stage female) removed, showing adult female enclosed within. × 35.

Figs. 5, 6.—Puparia of adult female, ventral, showing impressions of leaf tissues and accidental cracks on thin secretionary scale. × 35.

Fig. 7.—Adult female. × 60.

Fig. 8.—Pygidium of adult female. × 500.

Fig. 9.—Antenna of adult female. × 600.

Fig. 10.—Puparium of second-stage female. × 50.

Fig. 11.—Puparium of the male. × 50.

Fig. 12.—Newly hatched larva. × 80.

Fig. 13.—Antenna of newly hatched larva. × 600.

Fig. 14.—Pygidium of newly hatched larva (margin). × 600.

Fig. 15.—Insects natural size *in situ* on portion of leaf of *Æchmea aquilega*.

Genus Fiorinia (Targioni-Tozzetti).

The female puparium consists *almost entirely* of the moulted skin (exuviæ) of the second-stage female, which at the period of moulting becomes highly chitinised, remains intact, and completely encloses the adult insect. Dorsally it is usually covered by a very thin secretion, but in *F. Kewensis* the covering is abnormally thick, in which respect it differs from all other known species of the genus. The larval exuviæ are always placed at the cephalic extremity. At first the adult insect fills the moulted skin of the second-stage female, but the body shrinks at gestation and leaves room for the eggs, and subsequently the young

larvæ (Pl. XXIX, fig. 2). This singular habit has been previously noted in *Gymnaspis*, and it also occurs in *Aonidia*; but in both these genera the male puparia resemble those of *Aspidiotus*. In *Fiorinia* the male puparia resemble those of *Chionaspis*, etc., in having the larval exuviæ at the anterior extremity, and in being elongate, and composed of a *closely felted* white material, which may be either "with or without carinæ" (Green, 'Coccidæ of Ceylon,' p. 72).

Synopsis of Species.

A. Female puparium orange-brown, with a very thin transparent covering.
(I) . . . . . Fioriniæ.

B. Female puparium covered with a thick layer of white felted material.
(II) . . . . . Kewensis.

Fiorinia fioriniæ (Targioni-Tozzetti).

(Pl. XXIX, figs. 1—10.)

Diaspis fioriniæ, Targ.-Tozz. (1867); Studii Coccinniglie, p. 14.
Fiorinia pellucida, Targ.-Tozz. (1868); Catal., p. 436.
Chermes arecæ, Boisduval (1868); Insect. Agric.
Fiorinia camelliæ, Comstock; Rept., 1880, p. 329.
Uhleria camelliæ, Comstock; Rept., 1883, p. 111.
Fiorinia palmæ, Green; Indian Museum Notes (1896), vol. iv, No. 1.

Puparium of adult female (Pl. XXIX, fig. 1) chitinous; elongate, sides straight or slightly curved, narrowest at the extremities, with the anterior margin almost straight; dorsum usually with a strong, central, rounded keel—a character which is sometimes wanting,

but it is always highest in the centre, and has flat sloping sides. Colour varying from orange yellow to orange brown, with a darker central area. The foregoing applies chiefly to the second moulted skin (exuviæ) of the female, which completely envelops the adult insect, and forms the entire puparium, with the exception of a very thin secretionary covering, which extends slightly beyond the chitinous portion. The pale yellow larval exuviæ extend considerably beyond the anterior extremity. Ventral *skin* very thin, and when removed exposes the female and her eggs (Pl. XXIX, fig. 2).

Long. 1—1·25 mm.

Adult female (Pl. XXIX, fig. 3) at first elongate, but during gestation the abdominal segments contract and overlap the base of the pygidium. Colour dull orange yellow; segments during gestation orange or dark crimson; marginal area thin and paler than the rest; eye spots black. Rudimentary antennæ (Pl. XXIX, fig. 4) placed closely together on the extreme margin, in a slight hollow or emargination; are composed of a strong, central, straight, bidentate spine; and a single, outer, curved, slender bristle. Pygidium (Pl. XXIX, fig. 6) with five groups of circumgenital glands, of which the three anterior groups are confluent, and consist of from twenty-five to thirty; and the posterior laterals, each of from twelve to seventeen, are arranged in an irregular double row. Dorsal tubular spinnerets wanting; but there are three conspicuous marginal spinnerets with long broad spine-like projecting pores; the first is between the median and second lobes; the second between the third and fourth plate; and the third towards the middle. Sometimes there is a smaller additional spinneret near the preceding segment. Plates, short and spine-like, number about four on each side the median lobes. Spines minute. Median lobes, widely divergent, are regularly and finely serrate on the inner free margin; second and third pairs are close together, small, have

the margins either entire, or with an outer notch towards the extremity.

Second-stage female (Pl. XXIX, fig. 8) larger than the adult insect, elongate; has two or more sharp spine-like projections on free abdominal segments. Pygidium without circumgenital glands, otherwise not differing materially from that of the adult. Towards the period of moulting the dermis above becomes highly chitinised, and subsequently forms the puparium of the adult female, as already stated.

Adult male unknown.

Larva effects its moult in the same way as *Diaspis*. Antennæ of five joints, of which the last is longer than the rest together; formula 5 (1, 2) (3, 4).

Habitat (under glass).—It is a pest on seedling palms in Cheshire; and I have received it from Scotland and Ireland on the same kind of plants, but did not find it in the Royal Botanic Gardens, Kew. The infested leaves turn a sickly yellow colour (Pl. XXIX, fig. 10), with rusty-brown spots and blotches, which are sure indications of its presence.

Distribution.—Is common in the open air in S. Europe, U.S. America, Ceylon, Australia, and Brazil.

Description of the Plate.

Pl. XXIX, fig. 1.—Puparium of adult female (dorsal). × 25.

Fig. 2.—Puparium of adult female, ventral surface, with part of puparium removed, showing adult female, ova, and effete skins within. × 35.

Fig. 3.—Adult female at period of gestation. × 35.

Fig. 4.—Rudimentary antennæ of adult female. × 600.

Fig. 5.—Spiny plates of free abdominal segments of adult female. × 600.

Fig. 6.—Pygidium of adult female. × 250.

Fig. 7.—Margin of pygidium of adult female. × 600.
Fig. 8.—Female, second stage. × 40.
Fig. 9.—Antenna of larva. × 600.
Fig. 10.—Seedling palm leaf discoloured from the attacks of the insects.

Fiorinia Kewensis (Fig. 17) (Newstead).

Fiorinia Kewensis, Newstead; Entomologist's Mo. Magazine, S.S., vol. xii (1901), p. 82, figs. 3, 4.

Puparium of adult female elongate, widest in front, and considerably narrowed at the anal extremity;

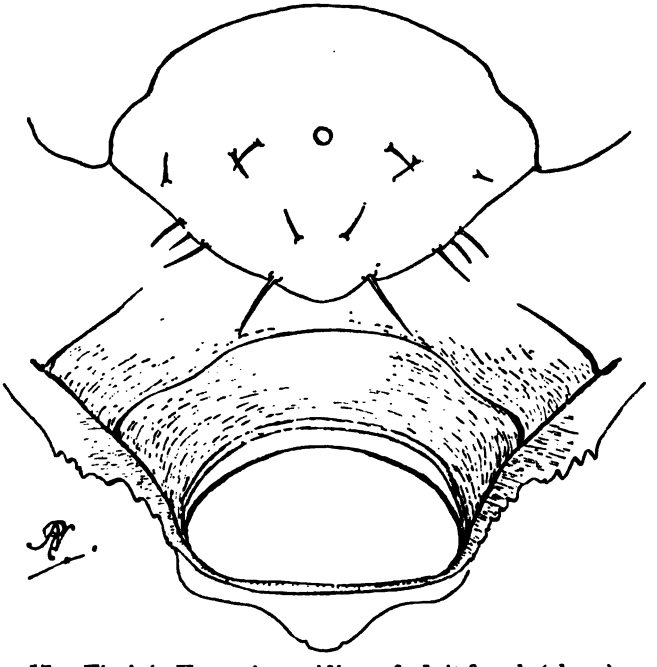

Fig. 17.—*Fiorinia Kewensis*, pygidium of adult female (above). × 250. Posterior extremity of cast skin of second-stage female forming puparium (below). × 250.

rounded convex; pure white and composed externally of a closely felted material which at the cephalic extremity extends in woolly filaments. Larval exuviæ at cephalic extremity, yellow or yellowish brown, are often covered by the felted secretion. The removal of the felted secretionary covering reveals the highly chitinised exuviæ of the second-stage female, which are of a pale castaneous colour, or sometimes yellow or dull crimson. At the posterior extremity of the second exuviæ (fig. 17 below) is a transversely ovate valve which affords a means of escape for the imprisoned larvæ.

Long. ·75—1 mm.

Adult female elongate; much smaller than the insect of the previous stage, and is completely enclosed within the moulted skin of the latter. Antennæ with three long spiny hairs. Spiracles encircled by minute parastigmatic glands. Pygidium (fig. 17 above), without circumgenital glands or tubular spinnerets, is furnished with about eight long spiny hairs at the margins, and four to six others on the dorsal area. Anal opening central. Position of vaginal opening not ascertained.

Puparium of male very elongate, without carinæ, rounded convex; widest immediately behind the larval exuviæ, and almost pointed at the posterior extremity. A number of woolly filaments occur at the anterior extremity as in the puparium of the female. Larval exuviæ at anterior extremity pale yellow or light castaneous.

Long. ·50—·70 mm.

Pupa yellow, with black eye-spots.

Larva somewhat elongate, has six-jointed antennæ, of which the first joint is very broad; two, three, four, and five equal, six about as long as the three latter. Formula 6, 1 (2, 3, 4, 5). Along the margin at the sides are a series of six to seven chitinous discs surmounted by a minute spine.

Habitat.—On *Howea Forsteriana*, in temperate house at the Royal Botanic Gardens, Kew, March, 1898. Received from the curator Mr. Nicholson.

This species has the singular habit of living in little colonies or family parties, which generally consist of one or two females and several males. The insects were very abundant upon the leaves submitted to me. It may readily be distinguished from all other known species by the thick, white, felted covering of the puparia, and the absence of circumgenital glands in the female.

Genus PARLATORIA (Targioni-Tozzetti).

The members of this genus, which are few in number, bear a somewhat superficial resemblance to *Fiorinia* owing to the large size of the second exuviæ —a character which is most marked in *P. zizyphi*. The adult female, however, is not enclosed within the second exuviæ, which only forms *part of the dorsal covering* or puparium as in *Aspidiotus*, etc., but to a much greater extent. The ventral scale in all the species hereafter described is thin, but can be removed from the plant tissues. In *P. zizyphi* it extends across the entire width of the puparium, but in *P. proteus*, *P. pergandii*, and the var. *crotonis*, the ventral scale only covers the, comparatively narrow, trough-shaped cavity, to the sides of which it is attached. The most salient generic character, however, is found in the structure of the pygidium of the adult female, which appears deeply crenulated owing to the many large marginal pores. The form and character of the lobes and plates in the various species differ only in the minutest details, which renders the species by no means easy to determine from mere descriptions (see Pl. XXXIII, figs. 1—3). Even in *P. zizyphi*, with its abnormally large second exuviæ, the characters of the pygidium of the female are obscure.

Mr. Maskell says this genus appears to exist (in the open air) only in tropical or warm countries.

As regards the male I can say very little, as it has

not been my good fortune to procure living examples, and such structural details as I have been able to make out from mutilated specimens do not offer any salient generic characters.

The male puparium is distinguished by its elongated form, its straight and usually perpendicular sides, and its low convex, non-carinated dorsum; which after the escape of the male becomes more or less concave.

Synopsis of the Species.

A. Puparium of the female elongate.
a. Pygidium with fourth rudimentary lobe absent.
(I) . . . . . Proteus.*
B. Puparium approximately circular.
b. Fourth rudimentary lobe of pygidium present.
(II) . . . . . Pergandii.
C. Puparium of female black.
c. Fourth lobe of pygidium distinct. Cephalic segment with a large tubercle.
(III) . . . . . Zizyphi.

Parlatoria proteus (Curtis).

(Pl. XXX, figs. 9—12; Pl. XXXII, figs. 3, 4; Pl. XXXIII, fig. 2.)

Aspidiotus proteus, Curtis (Ruricola); Gardeners' Chronicle, 1843, p. 676; figs. 4—7.
Parlatoria orbicularis, Targ.-Tozz.; Catal. (1868), 42.
Parlatoria proteus (Curtis); Signoret, Essai, p. 132, pl. ii, fig. 3; pl. v, figs. 5, 5*a*.

Puparium of adult female (Pl. XXX, fig. 9) elongate ovate, strongly convex, posterior extremity usually

* The var. *crotonis* may be recognised by the yellow elongate-ovate puparia of the female.

narrowest, but both extremities are sometimes attenuated; when overcrowded they are frequently pyriform, and the character of the puparium is often altered by contact with the venation of the leaf. Colour pale greenish yellow, subdorsal area often bright orange-yellow, margins paler; and being transparent the underlying ova, effete skins, and tissues of the leaf give it a variety of local colours depending upon the nature and contents of the puparium. Exuviæ at the cephalic extremity; those of the larva usually project slightly beyond the margin; are yellow and covered with a thin transparent secretion; second exuviæ occupying a little more than one third of the entire puparium, are broadly ovate or almost circular, and vary from greenish yellow to orange-brown; the transparent secretionary covering frequently forms a central and marginal carina. Cabinet specimens become opaque, and are dull ochreous or of a dirty straw colour.

Long. 1—1·90 mm. Wide ·25—·90.

Adult female (Pl. XXX, fig. 11) approximately circular, widest at abdominal segments. Colour variable, but usually of a pale translucent mauve or purple. Cephalic segment with a minute spine at the margin near the articulation. Rudimentary antennæ with a short spine. Rostral filaments extending slightly beyond the middle. Margins of four free abdominal segments, with numerous short tubular spinnerets. Pygidium (Pl. XXXIII, fig. 2) short, but very broad; has four groups of circumgenital glands; the formula of five examples are given below:

7—6	6—6	7—7	7—6	6—5
4—5	4—5	4—5	5—5	4—5

Dorsal tubular spinnerets short, and very broad. Vaginal opening opposite space between circumgenital glands. Anal opening just below the posterior groups. Margin of pygidium (Pl. XXXII, fig. 4) strongly crenulated. There are three pairs of well-developed lobes

which are subequal and strongly trilobate; fourth lobe entirely absent, and a broad palmate plate takes its place. Plates slightly extending beyond the lobes; there is a pair of precisely the same character between each of the lobes; they are slightly divergent, deeply fringed, and have the apical serration longest and stoutest; beyond the third lobe are usually seven broadly palmate plates, deeply fringed, each having the apical serration longest and stoutest; each of the preceding segments have four to five plates of a similar character, but are much less palmate and subject to great variation. As the apical serrations of all the plates take the stain more readily than the rest, presumably they are the only ones which are hollow and secreting. The first two spines are immediately anterior to the median and second lobes; the third a little beyond the last lobe; and the fourth about midway between the latter and the first segment. There is a regular series of large equidistant marginal pores which gives the crenulated character to the margin; the connecting tubes are short and very broad.

Puparium of the male (Pl. XXX, fig. 10) very elongate, sides parallel and perpendicular; flat convex when tenanted, after the emergence of the male it is usually strongly concave; laminæ often strongly indicated. Cabinet specimens are dull ochreous or straw coloured, with the basal area smoky brown. Exuviæ apical, posterior extremity elevated; are pale yellow, with a dark green dorsum.

Long. ·90 mm.

Habitat.—In his original diagnosis of the species in the 'Gardeners' Chronicle' of 1843, Curtis ("Ruricola") says this insect was abundant on *Aloë* and *Amaryllis*. I have had the species from various localities on orchids (*Dendrobium*, spp.), but I have not found it so generally distributed or so abundant as one might imagine after being so long established in this country.

Distribution.—Plentiful on cultivated plants throughout Europe, especially *Selenipedium* and *Vanda*. It

has been met with in Japan; Prof. Comstock found it on *Microsamia* in the United States; Prof. Hempel records it from Brazil; and Mr. Maskell records it from Australia on apple.

Description of the Plates.

Pl. XXX, fig. 9.—Puparium of adult female. × 15.
Fig. 10.—Puparium of male. × 20.
Fig. 11.—Adult female at period of gestation. × 40.
Fig. 12.—Insects natural size on portion of leaf of *Cypripedium*.
Pl. XXXII, fig. 3.—Adult female after treatment with potash. × 50.
Fig. 4.—Fringe of pygidium of adult female. × 600.
Pl. XXXIII, fig. 2.—Pygidium of adult female. × 250.

Parlatoria pergandii (Comstock).

Pl. XXX, figs. 1—3; Pl. XXXII, figs. 1, 2; Pl. XXXIII, fig. 1.

Parlatoria pergandii, Comstock; Rep., 1880, p. 327, pl. xi, fig. 4; pl. xx, fig. 5. Report, 1883, p. 113, pl. ii, fig. 6.

Puparium of the female (Pl. XXX, fig. 1) very variable in form; it is often more or less circular or broadly pyriform, and sometimes elongate; it is smooth and semi-transparent, showing, indistinctly, the sublying female. Colour dusky white, tinged with pale reddish brown; exuviæ marginal, but rarely projecting, are dull orange brown or yellow; secretionary covering thin and transparent, but usually opaque white at the margins. Cabinet specimens become more or less

opaque, and of a dull ochreous or smoky yellow; and rough in texture. Underside trough-shaped, with broad, flat, lateral margins. Ventral scale complete, white or dusky white.

Long. 1—1·75 mm.

Adult female (Pl. XXX, fig. 1) nearly as broad as long; usually of a translucent mauve or pale purple, with the pygidium yellowish; eye-spots dark purplish; and the dark colour of the eggs readily shows through the dermis when ready for extrusion. Young adults are frequently quite colourless. Rudimentary antennæ near the margin. Marginal spine placed as in *P. proteus*. Rostral filaments extending to the middle of the body. Margins of abdominal segments with many short tubular spinnerets.

Pygidium (Pl. XXXIII, fig. 1) with four groups of circumgenital glands, which do not vary to any great extent, as will be seen by the formula of the ten examples given below:

6—8 .	6—6 .	6—7 .	7—7 .	6—6
8—9 .	8—7 .	6—8 .	6—6 .	6—7
9—8 .	6—6 .	8—10 .	7—6 .	6—6
7—6 .	6—6 .	7— 7 .	6—6 .	6—6

Margin with three pairs of well-developed, subequal, and strongly trilobate lobes, the bases of which are all suddenly narrowed; fourth pair rudimentary, and usually pointed or tridentate, and occasionally are so minute as to appear as a thickened margin of the body-wall; a spine indicates its position, which, when standing erect, might easily be mistaken for a pointed process on the lobe itself. There are two plates between the median and second pair of lobes; three between the second and third pair, which, with the exception of the fifth, are identical in form; like those of *P. proteus* they are slightly divergent and deeply fringed, but the apical serration is less pronounced than in the latter species; the three plates between

the third and fourth lobes, and those beyond, are deeply fringed and broadly palmate. The plates on the succeeding segments are narrow, and gradually diminish from the deeply fringed to the bluntly dentate or tuberculate form There is a spine at the base of each lobe on the outer margin, and a fifth just beyond. Marginal pores, very large, do not differ in character from those of *P. proteus*.

Puparium of the male similar to that of *P. proteus*. Smoky brown or purplish brown behind the exuviæ; posterior half greyish. Cabinet specimens pale ochreous or straw-coloured. Larval exuviæ dull yellow or dark orange-yellow, with black or dusky centres.

Long. 1 mm.

Prof. Comstock describes the male as purplish in colour, with the disc of the thorax nearly colourless, with the exception of some irregular purplish spots, and the sutures which are brownish; the eyes are large and very dark.

Habitat.—Exceedingly common on imported oranges in this country, but I have never met with it on cultivated plants.

Distribution.—A common orange pest throughout the south-west of the United States, in the West Indies, and the Mediterranean area. But Mr. Maskell does not record it from Australia or New Zealand.

Explanation of the Plates.

Pl. XXX, fig. 1.—Puparium of adult female. × 15.
Fig. 2.—Adult female at period of gestation. × 40.
Fig. 3.—Puparium of male. × 20.
Pl. XXXII, fig. 1.—Adult female after treatment with potash. × 50.
Fig. 2.—Fringe of pygidium of adult female. × 600.
Pl. XXXIII, fig. 1.—Pygidium of adult female. × 250.

PARLATORIA PROTEUS, var. *crotonis* (Douglas).

(Pl. XXXI, figs. 1—10.)

Parlatoria proteus, var. *crotonis*, Douglas; Ent. Mo. Mag., vol. xxiii, p. 242, 1887.

Parlatoria pergandii, var. *crotonis*, Cockerell; Coccidæ from the island of Antigua. Annals and Mag. of Nat. Hist., Ser. 6, vol. xvi, July, 1895, p. 62.

Puparium of adult female (figs. 1—3) elongate ovate, or pyriform, flat convex. Orange-yellow faintly tinged with green, the laminations usually much darker. Exuviæ marginal; those of the larva ovate, and frequently projecting, are yellow with a posterior blotch of dark bluish-green; second exuviæ, almost circular, occupy more than one third of the puparium, and of the same colour as those of the larva; secretionary covering usually forming a complete marginal ring.

In cabinet specimens the margin of the puparium becomes greyish; the dark blue-green patch on the first and second exuviæ fades; but the orange-yellow of the puparium remains bright for an indefinite period. The ventral surface is trough-shaped, and when viewed by transmitted light (fig. 4) the broad flat lateral margins are seen to be ramified by branched vessels resembling capillaries, and are very strongly indicated in fresh examples.

Long. 1·50—2 mm.

Adult female (fig. 5) usually of a faint, translucent, purple or mauve, with crimson blotches on the cephalic and thoracic segments. Papillæ on the dermis of cephalic area much more chitinised and conical, but fewer than in *P. pergandii;* and the hairs are almost entirely wanting. The groups of circumgenital glands are remarkable for the constancy of their numbers, as

will be seen on comparing the following formula of ten examples:

4–6	6–6	6–6	6–6	5–6	6–6	6–6	6–6	6–6	5–6
5–4	5–5	4–5	5–4	5–6	5–5	5–5	5–5	5–5	5–5

Rudimentary antennæ (fig. 8) with a single curved spine.

Puparium of the male (figs. 6, 6 A) of the same shape as typical *P. proteus*. Colour purple brown behind the exuviæ, posterior half greyish, often with a faint trace of yellow. Exuviæ occupy about one third of the puparium, have the central area intense dark bluish green, and the margin yellow or orange yellow.

Male.—I have only been able to obtain imperfect examples of this sex. The lower half of the tibiæ and the whole of the tarsi (figs. 9, 10) are clad with fine hairs; and the single pair of digitules are scarcely as long as the slender claws.

Habitat.—In the palm house of the Royal Botanic Gardens, this well-marked variety is common on all the cultivated crotons. Its favourite position is along the underside at the extreme margin of the leaf, which, from its deflexed character, partly conceals the puparia. But as the insects become more numerous they spread themselves over the surface of the leaves, when they can be readily seen and to the naked eye appear as small elongated bodies of yellow wax. Subsequently when the insects are dead the puparia have very much the appearance of "bran" scattered over the leaves of the food-plant, a similarity which has gained for it, among horticulturists, the name of "bran scale."

I have also received the species from various parts of Cheshire; and it is probably to be met with on crotons in many other places.

Distribution.—Is probably common wherever the croton is cultivated. Mr. Cockerell records it from Antigua and Jamaica.

EXPLANATION OF THE PLATES.

Pl. XXXI, fig. 1.—Puparium of adult female (dorsal). × 25.

Fig. 2.—Puparium of adult female (ventral) with ventral scale almost complete. × 25.

Fig. 3.—Puparium of adult female (ventral) with ventral scale removed, disclosing female and eggs. × 25.

Fig. 4.—Puparium of adult female as seen by transmitted light: *a*, larval exuviæ; *b*, second exuviæ; *c c*, secretionary portion; *d*, ova; *e*, effete skins of ova; *f*, "branched vessels" (see description).

Fig. 5.—Adult female at period of gestation. × 40.

Fig. 6.—Male puparium (dorsal). × 25.

Fig. 6 A.—Male puparium (ventral) with ventral scale ruptured, disclosing the imprisoned male within.

Fig. 7.—Insects natural size *in situ* on portion of croton leaf.

Fig. 8.—Rudimentary antennæ of adult female. × 600.

Fig. 9.—Leg of male. × 250.

Fig. 10.—Tarsus and claw of male. × 600.

PARLATORIA ZIZYPHI (Lucas).

(Pl. XXX, figs. 4—8; Pl. XXXII, fig. 5; Pl. XXXIII, fig. 3.)

Coccus zizyphus, Lucas (1853); Ann. Soc. Fr. Bull., xxviii.

Kermes aurantii, Boisduval (1867); Ent. Hort., 338.

Parlatoria Lucasii, Targ.-Toz. Catal. (1868), 42.

Parlatoria zizyphi (Lucas), Signoret; Essai, p. 133, pl. v, figs. 9, 9 *a—c*.

Puparium of the adult female (Pl. XXX, fig. 4) very elongate, composed almost entirely of the opaque,

black, moulted skin of the second-stage female, with a narrow white or brownish-white supplementary secretion, which at the posterior extremity is sometimes extended, and forms about one fourth of the length of the puparium; usually, however, there is a very narrow secretionary supplement, and sometimes it is entirely wanting. Larval exuviæ usually project beyond the anterior margin; opaque black and sometimes has a dorsal carina, and when quite perfect covered with a delicate transparent secretion. Second exuviæ rectangular, angles rounded; finely rugose; posterior margin frequently with a central projection; dorsum usually has a deep, broad, longitudinal furrow with a faint carina at the bottom. Sometimes several transverse carinæ arise from the margin, but their number and position are extremely variable. The thin secretionary covering is white and semi-transparent, and is usually present in young adults; but in the old examples it is almost invariably worn away. When present it gives the exuviæ a greyish appearance.

Ventral scale complete; is composed of secretionary matter, and is of a pale brownish colour or white. It is attached to the margins of the moulted skin of the second-stage female; and on its removal exposes the whole ventral surface of the dorsal exuviæ, which have a highly polished surface.

Long. 1·25—2 mm.

Adult female (Pl. XXX, fig. 8) after treatment with potash short ovate, cephalic segment well defined and bears, near its articulation, a large projecting tubercle which is furnished towards the apex with a minute spine. Rudimentary antennæ, with a long slender spine, are placed rather closely together immediately above the rostrum. The rostral filaments are rather long and extend to the second free abdominal segment. Margins of free abdominal segments with short tubular spinnerets; and there is a small spine at the commencement of the first. Pygidium (Pl. XXXIII, fig. 3) with four groups of circumgenital glands; the

anterior laterals of from 6—7; and the posterior laterals from 8—10.

The lobes (Pl. XXXII, fig. 5) are in four pairs; of these the first three pairs are well developed and subequal; but they are not so strongly trilobate as those of the preceding species, and the basal portions are decidedly more attenuated; the fourth lobe is narrow and pointed, and about half the length of the third lobe, but compared with that of *pergandii* it is highly developed. The arrangement of the spines is similar to those of the last-named species; but the anal and vaginal openings are placed somewhat closer together.

Puparium of the male (Pl. XXX, fig. 6) white, often stained brown or yellow; very elongate, and departs somewhat from other species in having the secretion extended at the sides immediately behind the exuviæ, giving that portion of the puparium a bulged appearance. Larval exuviæ black; the secretionary covering, thin and white, is usually wanting in old examples.

Long. 1 mm.

Male.—Legs hairy on the tarsi and anterior half of the tibiæ.

Habitat.—Common on imported oranges, but is especially so on the Tangerine and Seville varieties. They are most frequently met with on inferior fruit, and I have counted as many as fifty examples to the square inch. Not the least remarkable fact concerning these insects is the ignorance which generally exists concerning them. I have never met with a fruiterer who ever recognised them as insects; but find the general impression is that they are "seeds," and they pass as such by the majority of those who deal in them. I once asked a vendor how he accounted for the presence of the fixed "seeds" upon the orange rind. His reply was that he supposed they became attached while the fruit was lying upon the ground! He could give no other explanation!

Distribution.—Very abundant and destructive to oranges in the Mediterranean area. Mr. Maskell re-

cords it from Formosa, China, on *Citrus* and *Psidium*; and I have little doubt it has been imported into many parts of the world on citrus fruits.

Explanation of the Plates.

Pl. XXX, fig. 4.—Puparium of adult female. × 15.
Fig. 5.—Puparium of second-stage female. × 40.
Fig. 6.—Puparium of male. × 20.
Fig. 7.—Insects natural size *in situ* on orange rind.
Fig. 8.—Adult female after treatment with potash. × 50.
Pl. XXXII, fig. 5.—Fringe of pygidium of adult female. × 600.
Pl. XXXIII, fig. 3.—Pygidium of adult female. × 250.

Genus Diaspis (Costa).

This genus is distinguished by the, more or less, circular puparium of the adult female, and by the exuviæ upon it being always placed well within the margin. The larval exuviæ are naked, or have an imperceptible secretionary covering; those of the second stage occupy about one fourth of the diameter of the puparium, and are covered by a layer of secretion.

Of the species found in this country *D. zamiæ* is somewhat abnormal in the female having no circumgenital glands, but in other respects the general character of the pygidium does not materially differ from the more typical species.

The puparium of the male is strongly tricarinate in *D. boisduvalii* and *D. bromeliæ*, but in *D. calyptroides* the carinæ are either absent or faintly indicated. The non-carinated forms I consider imperfect; and I do

not see (so long as the puparia are tricarinate) that it matters whether they are faintly so or strongly pronounced. Mr. Cockerell, however, considered such a character of generic importance, and on these grounds alone established his genus *Aulacaspis*, including in it all species having very strongly tricarinate male puparia. I have retained *Diaspis rosæ* in *Aulacaspis*, but for other reasons than that given by the author. See diagnosis of genus.

Synopsis of Species.

A. Pygidium with five groups of circumgenital glands.

a. Thoracic segment with a large projecting tubercle; inner margin only of median lobes free.

(I) . . . . Boisduvalii.

b. Thoracic tubercle wanting; inner margin of median lobes free and serrate as in *a*. Dorsal tubular spinnerets large.

(II) . . . . Bromeliæ.

c. Both margins of median lobes free and non-serrate. Dorsal tubular spinnerets small and very numerous.

(III) . . . . Calyptroides.

d. Median lobes as in *c*. Dorsal tubular spinnerets almost wanting.

(IV) . . . . Caruelii.

B. Pygidium without grouped circumgenital glands.

a. Plates usually bifurcate.

(V) . . . . Zamiæ.

DIASPIS BOISDUVALII (Signoret).

(Pl. XIII, figs. 8—10; Pl. XVI, fig. 2; Pl. XVIII, figs. 2, 8.)

Diaspis boisduvalii, Signoret; Essai (1868), p. 114, pl. v, figs. 1, 2.

Diaspis tentaculatus, Morgan; Ent. Mo. Mag., 1893, p. 41.

Puparium of adult female approximately circular or ovate, low convex, semi-transparent, revealing the sublying female and eggs. This gives it a dull yellow colour and a wax-like appearance. Exuviæ towards the centre are pale yellow. Cabinet specimens become more opaque, rougher in texture, and are usually of a pale ochreous or straw colour; and the exuviæ of a dusky yellow. Ventral scale a thin mealy secretion upon the food-plant. To the unaided eye the tenanted puparia appear as scales of yellow wax. The loose epidermal layer of certain food-plants is sometimes mixed with the secretion, and thus alters the character of its surface.

Diam. 1·25—2·25 mm.

Adult female (Pl. XIII, fig. 9) widely ovate, narrowed and slightly extended posteriorly. Thoracic segment with a large projecting marginal tubercle at each side. Free abdominal segments, clearly indicated, have a few spines at the margin. Rudimentary antennæ with a single curved spine. Rostral filaments usually terminating just beyond the posterior spiracles. Parastigmatic glands present with the anterior spiracles only; each group numbers about eighteen, they are very small, and broken up into small sub-groups. Dermis with a few minute spinnerets. Spiracles shaped like those of *Aspidiotus hederæ*.

Pygidium (Pl. XVI, fig. 2) with five groups of clearly defined circumgenital glands, varying in

number as shown in the accompanying formula taken from thirteen individuals:

11	10	8	11	12
20—24	21—22	14—14	21—17	20—18
17—17	16—16	13—14	16—14	14—15
8	13	18	4	11
12—12	25—24	16—22	19—16	22— 6
9—11	14—16	17—17	16—17	16—16
	12	9	8	
	21—22	24—25	19— $\frac{4}{7}$	
	18—17	20—17	7—14	

Dorsal tubular spinnerets short; those at the margin and four near the median line much the largest. Vaginal opening opposite space between the glands. Anal orifice just below the posterior groups. Median lobes (Pl. XVIII, fig. 2) large, widely divergent, their outer lateral margins attached to the body, inner margin free and finely serrate; second and third pairs very short, each divided and separated towards the centre, the anterior portion usually the largest; fourth pair quite rudimentary, or entirely wanting. A long plate immediately follows the first three pairs of lobes, and beyond them 5—7 others, equidistant, but shorter and broader. Immediately following the first three plates is a large *projecting* tubular spinneret (pore); and a fourth about the middle of the margin. Spines short, median pair longest. The female may be readily distinguished by the large thoracic tubercle.

Puparium of the male, strongly tricarinate, has a varying quantity of curly, woolly filaments arising from the thick felted material. When the individuals are crowded together, as is frequently the case, the filaments increase greatly and form a continuous patch of secretion completely obscuring the true character of the puparia.

Long. ·75—1 mm.

Male bright orange yellow; antennæ and legs much paler, sometimes colourless; thoracic bands scarcely darker than the rest of the body; stylus glassy, much longer than abdomen; eyes and ocelli black; ventral ocelli much the largest. Antennæ long and thickly set with long hairs; apical joint with the central hair faintly clubbed. Claws long; digitules ordinary.

Larva yellow, broadly ovate. Antennæ of 6 joints, 6 equalling 2, 3, 4, and 5 together. Formula 6, 1 (2, 3, 4, 5). Legs ordinary. Pygidium with two stout spines on each side of the caudal setæ.

Ova pale yellow.

Habitat.—One of the commonest and most widely distributed of our greenhouse pests. It occurs almost everywhere on cultivated palms, and is a great pest on *Calanthes*, infesting the pseudo-bulbs. At Kew Mr. Green and I met with it on the following plants: *Cocos Romanzoffiana*, *Heliconia metallica*, *Nannorhops Ritchiana*, *Æchmea mexicana*, *E. Saundersii*, *Pitcairnia bromeliæfolia*, *P. latifolia*, *P. alta*, *Bactris acanthocarpa*, and *Euterpe speciosa*.

Mr. Bennett-Poë sends it on *Anguloa Clowesi;* and Mr. Burbidge (Dublin Bot. Garden) on *Corypha australis*.

The species shows a decided preference for monocotyledons, and is a troublesome pest in nurseries to young pot palms; it can only be kept in check by repeated "washings." If the plants are neglected they speedily become covered, chiefly on the undersides of the leaves, by the scales which give the plants a white appearance. Frequently the leaf is stained yellow round the scale, and in a single instance on *Broughtonia*, sp., I noted the stains were pale crimson.

Distribution.—Occurs almost everywhere on cultivated plants under glass; and in the open air in the West Indies and the Sandwich Islands.

Description of the Plates.

Pl. XIII, fig. 8.—Insects natural size *in situ* on portion of palm leaf.

Fig. 9.—Adult female after treatment with potash. × 45.

Fig. 10.—Thoracic tubercle after treatment with potash. × 500.

Pl. XVI, fig. 2.—Pygidium of adult female. × 250.

Pl. XVIII, fig. 2.—Margin of pygidium of adult female. × 600.

Fig. 8.—Antenna of larva. × 600.

Diaspis bromeliæ (Kerner).

(Pl. XIII, figs. 1—7; Pl. XVI, fig. 1; Pl. XVIII, fig. 1.)

Coccus bromeliæ, Kerner (1778); Naturgeschichte der *Coccus bromeliæ*, Stuttgart, 1788.

Coccus bromeliæ, Curtis (Ruricola); Gard. Chron., 1841, p. 131, figs. 1—6.

Coccus bromeliæ, Bouché; Ent. Zeit. Stettin (1844), 295.

Coccus bromeliæ (Bouché); Boisduval, Ent. Hort. (1867), 334.

Diaspis bromeliæ (Kerner), Signoret; Essai, p. 116.

Puparium of the female (Pl. XIII, fig. 2) approximately circular, flat convex, and semitransparent, when free from the admixture of foreign substance, as such examples are when they occur upon the fruit; but those examples upon the leaves are almost hidden beneath the scurfy epidermal layer. Exuviæ towards the margin, vary from dusky yellow to pale brown.

Diam. 2·25—3 mm.

Adult female (Pl. XIII, fig. 3) at period of gestation pyriform, widely rounded in front where there is a deep central emargination. Segments very pronounced; those of the abdomen tuberculate at the margins, and often asymmetrical; pygidium extended. Colour yellow or orange-yellow; young adults much paler; at the period of gestation it changes to a deep orange colour. Pygidium (Pl. XVI, fig. 1) with five groups of circum-genital glands; the anterior group usually consists of from 8—9; the anterior laterals from 14—20, and the posterior laterals from 13—17; formula of seven examples:

9	10	9	8	8
14—28	19—18	21—18	17—19	20—18
13	16—17	17—13	14—16	16—14

8	9
16—19	17—19
15—16	16—16

In the first example it will be seen that the right anterior and posterior groups are united, making in all 28; this is quite a freak of nature, but I have noted similar malformations in other species of the *Diaspinæ*. Dorsal tubular spinnerets short and cylindrical, and number about 10—13 on each side of the dorsum; there are from 8—10 others of similar structure connected with the margin, some of which have long projecting pores. Margin of pygidium (Pl. XVIII, fig. 1) with three pairs of lobes; median pair largest, divergent, finely serrate on the inner margin, distal extremity of outer margin free; second and third pairs, almost equal, are deeply divided and appear as double lobes; the extremities of the lobules are usually broadly rounded. The fourth pair of lobes are quite rudimentary. All the plates are simple and spine-like, and there are usually eight on either side of the dorsum; the first three are immediately anterior to the lobes;

each one is succeeded by a long projecting pore, and there is an additional fourth pore which is much the largest, has a pointed upturned apex, and is placed at or near the centre of the margin. The spines are small, and the first pair placed between the median lobes.

Puparium of the male closely resembles that of *D. boisduvalii* in having a number of woolly filaments attached to it, but they are much less abundant, and the larval exuviæ are of darker colour.

Long. ·75—1 mm.

Male (Pl. XIII, fig. 6) orange-yellow; apodema brightest; legs and antennæ paler; wings pale hyaline. Eyes and ocelli black. Antennæ of ten joints thickly set with long stiff hairs; apical joint with central hair faintly clubbed. Legs ordinary; tibiæ and tarsi with long hairs; digitules and claw ordinary.

Larva short ovate; pale yellow.

Ova pale translucent yellow or colourless, elongate, and sometimes slightly curved.

Habitat.—Curtis first called attention to this species in the 'Gardeners' Chronicle' for 1841, and says "the pine-apple scale is often a great pest. . . On pulling off a radial leaf . . . I found considerable numbers on the inside of the white part, which was tender and afforded them shelter." The author makes no mention of the locality; but there can be no doubt the species had well established itself in this country at the time of his communication.

During my own experience in the cultivation of the pine-apple I never met with the insect, and doubt if it can be considered a general pest in this country. The examples for figuring were obtained from imported pine-apples offered for sale in Chester. They occurred chiefly on the green unripe side of the fruit, and were often partly hidden in the deep sutures; frequently too they were quite concealed within the perianth, and there it was the males abounded. It is evidently a hardy species; for although exposed for

several days to the open air in the fruiterer's shop in the month of April, the males readily hatched out when the fruit was placed in a temperature of about 80° F. I have now quite recently received it on pine-apple cultivated in the London district, where it was collected by Mr. Lovell Reays.

Distribution.—Said to be common and destructive to pineapple (*Ananassa sativa*) under cultivation in Europe. Prof. Comstock found it in a conservatory at Washington; but I do not know that it has been found in a wild state in the United States.

Explanation of the Plates.

Pl. XIII, fig. 1.—Insects natural size *in situ* on portion of pineapple (perianth).
Fig. 2.—Puparium of adult female. × 20.
Fig. 3.—Adult female at period of gestation. × 35.
Fig. 4.—Adult female after parturition. × 35.
Fig. 5.—Puparium of male. × 20.
Fig. 6.—Male. × 35.
Fig. 7.—Ova.
Pl. XVI, fig. 1.—Pygidium of adult female. × 250.
Pl. XVIII, fig. 1.—Margin of pygidium of adult female. × 600.

Diaspis calyptroides (Costa).

(Pl. XIII, figs. 11, 12; Pl. XVI, fig. 3; Pl. XVIII, fig. 3.)

Diaspis calyptroides, Costa (1827); Faun. Nap., pl. vi, fig. 2.
Aspidiotus echinocacti, Bouché; Schadl. (1883), 53.
Diaspis calyptroides (Costa), Signoret; Essai, p. 116.
? *Diaspis cacti*, Comstock; Rept., 1883, p. 91, fig. 11.

Diaspis opunticola,* Newstead; Ent. Mo. Mag., 1893, p. 188, pl. iii, fig. 4, p. 281.
Diaspis cacti, var. *opuntiæ*, Cockerell; Journ. Inst. Jamaica, vol. i, p. 256.

Scale of the female convex, approximately circular, opaque white, and sometimes with a tinge of yellow. Exuviæ subcentral, or towards the margin; in overcrowded examples they are frequently marginal, but such examples are abnormal. Colour dusky ochreous brown to almost black. Secretionary covering to the exuviæ thin and transparent. Ventral scale thin, is attached to the plant tissues, and often partakes of their structure.

Diam. 2—2·25 mm.

Adult female (Pl. XIII, fig. 12) pyriform, very widely rounded in front, and somewhat suddenly attenuated behind. Segmentation not very pronounced; margin of the three free abdominal segments broadly set with short tubular spinnerets, of a similar character to those of the pygidium. Rudimentary antennæ with a long and much curved spine. Parastigmatic glands, about six in number, present with the anterior spiracles only.

Pygidium (Pl. XVI, fig. 3) has five groups of circumgenital glands; the anterior group consists of from 9—15; the anterior laterals 12—23; and the posterior laterals from 10—24. Formula of fifteen examples:

9	9	12	12	12	15
15—12	12—18	19—17	19—19	14—15	20—23
12—11	15—17	11—12	12—10	19—24	12—13
13	9	9	13	9	9
18—14	22—21	19—21	18—14	22—21	19—21
14—10	18—13	17—13	14—12	18—13	17—13

11	12	13
23—18	18—20	20—18
15—15	16—15	15—13

* Vice *opuntiæ*, Ent. Mo. Mag., 1893, p. 188.

Dorsal tubular spinnerets very numerous, occupying almost the whole of the dorsal area; those at the margin with their projecting pores are much the largest, and of the same character as those occupying a similar position in other species of *Diaspis*. The median lobes have both margins free, are widely rounded, slightly divergent, and without serrations; the second and third pairs are divided, and appear as two lobes; the anterior lobule in each case being much the smallest. Plates simple and spine-like, of which the second, third, and fourth are longest; there are two short ones between the median lobes; the two next are placed between a lobe and a long, pointed, projecting spinneret or pore; five or six others are placed at intervals along the rest of the margin, and gradually diminish as they approach the segment. There is a strong spine over each anterior lobule, and two or three beyond. Of the marginal pores or tubular spinnerets there is one median and usually seven others. The chief salient characters of the female are the abundant dorsal tubular spinnerets, and the non-serrate form of the median lobes.

Puparium of the male white; flat and faintly tricarinate, but sometimes the carinæ are entirely wanting. Exuviæ dusky ochreous brown. When large colonies are crowded together, a few short woolly filaments are secreted, but to a very much less extent than in *D. boisduvalii;* isolated examples do not appear to secrete them.

Male.—Although the male puparia usually occur in predominating numbers, I have never been able to obtain a perfect male; and I am obliged to refer to Signoret's 'Essai' for a description of it, which he says is "d'un jaune orangé, avec les élytres d'un blanc rosé."

Habitat.—I have only met with this insect at the Royal Botanic Gardens, Kew, where it is a recognised pest on the various species of *Cacti* in the Succulent House.

Distribution.—Occurs in the open air in the south of

Europe, Algeria, New Mexico, and Demerara; and elsewhere, under glass, on cultivated *Cacti*. Examples of the puparia, which have been submitted to the rays of the tropical sun, are of a pale brown or buff colour.

Explanation of Plates.

Pl. XIII, fig. 11.—Insects natural size *in situ* on portion of cactus.

Fig. 12.—Adult female after treatment with potash. × 45.

Pl. XVI, fig. 3.—Pygidium of adult female. × 250.

Pl. XVIII, fig. 3.—Margin of pygidium of adult female. × 600.

Diaspis carueli (Targioni-Tozzetti).

(Fig. 18.)

Diaspis carueli, Targ.-Tozz.; Catal., 1868.

Diaspis carueli (Targ.-Tozz.); Signoret, Essai, p. 118.

? Diaspis juniperi, Bouché; Ent. Zeit. Stett., 1851, xii, 111.

Female puparium more or less elongate, irregularly pyriform, or approximately circular, very convex, highest towards the anterior margin. White, but almost covered with a sooty deposit, which gives them a dirty grey appearance. Underside pure white, with a faint tinge of yellow indicating the position of the exuviæ. Exuviæ within the margin in front; pale translucent yellow or colourless; secretionary covering thin and colourless.

Diameter ·75—1·75; average diameter 1 mm.

Adult female pyriform, narrowed behind; yellow or dirty greenish yellow. Rudimentary antennæ placed closely together, each with a single long spiny hair. Anterior pair of spiracles, placed close to the base of the mentum, are usually accompanied by a single pair

of glands. Basal portion of mentum very broad. Free abdominal segments with groups of tubular spinnerets at the margins; and there are three intermediate groups near each articulation, each group consisting of four spinnerets arranged in a transverse linear series, forming a conspicuous feature in the character of the insect. Pygidium (Fig. 18) with

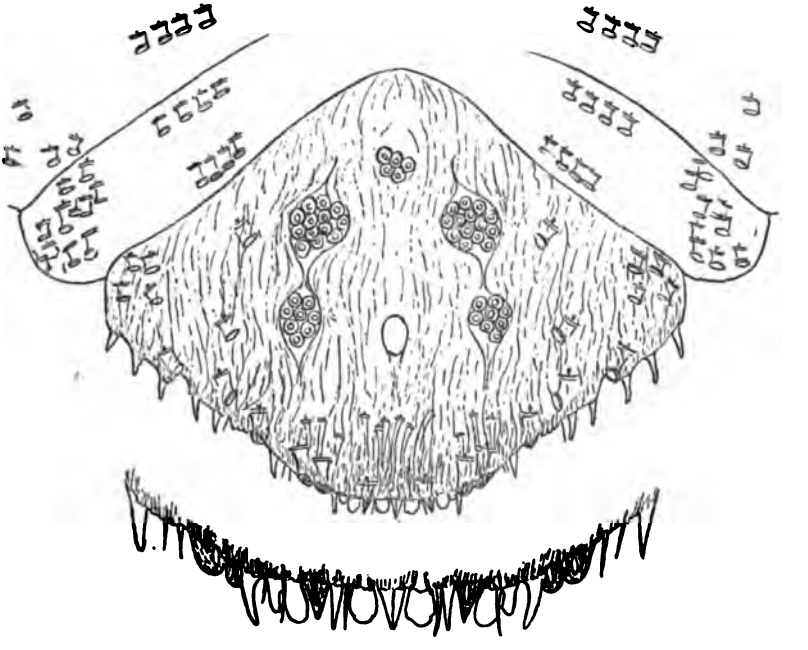

FIG. 18.—*Diaspis carueli.* Pygidium of adult female. × 250 (upper woodcut). Margin of pygidium. × 600 (lower woodcut).

five groups of circumgenital glands, which do not show a great variation in their numbers, as will be seen in the following formula of seven examples:

5	6	7	7
13—13 .	11—12 .	12—11 .	12—10
8— 8 .	8— 8 .	8— 7 .	8— 9
8	8	8	
12—12 .	13—12 .	11—12	
8— 8 .	8— 8 .	8— 7	

Subdorsal groups of tubular spinnerets are represented by two isolated examples.

The margin (Fig. 18, below) has but two pairs of lobes placed at the somewhat truncate extremity; median pair, slightly widest posteriorly, have the margins either rounded and entire, or slightly notched; the second pair are bilobed, the anterior lobule usually the smallest, and about one-third the width of the other. The median pair of plates and the single one between the median and second lobes very short; seven others, arranged along the margin at irregular intervals, are much larger and very distinct. Median pair of tubular spinnerets with sharp projecting spine-like pores; the remaining five on either side have rounded projecting pores. There is a median group of six to eight long slender tubular spinnerets, and a smaller group near them. About six spines occur on each side of the median lobes.

Long. ·50 mm.

Puparium of male white; tricarinate, central carina strongest, those at the sides faintly indicated or entirely obliterated. Exuviæ pale yellow.

Long. ·75.

Habitat.—On *Juniperus virginiana* at the Royal Botanic Gardens, Kew; which at present is the only known habitat in the British Isles.

The curator, Mr. G. Nicholson, who kindly supplied the specimens, says "the shrub was raised at Kew in 1891, but whether from seeds or cuttings is not known. It is from variety *horizontalis*—an old collection plant, and is probably from cuttings" (March, 1898). It is just possible the insect may have been introduced, prior to 1891, upon continental plants. In any case it is a very hardy species, and has thriven most remarkably in this country, the branch submitted to me being almost covered with the insects.

Easily recognised from other British species by its small size and the scurfy nature of the scales, which readily come away from the plant.

Distribution.—It is common in many parts of Southern Europe, and Prof. Comstock also found it in the United States. It is undoubtedly partial to the juniper and other conifers of that type.

DIASPIS ZAMIÆ (Morgan).

(Pl. XV, figs. 14—17; Pl. XVII, fig. 1; Pl. XVIII, fig. 4.)

Diaspis zamiæ, Morgan, Ent. Mo. Mag., S.S., vol. i, 1890, p. 44.

Howardia elegans, Leonardi, Diagnosi di Cocciniglie nuove (Nota di A. Berlese e G. Leonardi, estr. dalla Riv. di Patol. Veget., Anno iv, Num. 7—12), p. 348.

Puparium of adult female (Pl. XV, fig. 15) transversely ovate, or approximately circular, high convex; when free from the admixture of plant tissues has a texture resembling that of fine pale yellow wax, but there is often a free admixture of dermal hairs, etc., which gives the secretionary matter a rougher surface. Many examples are transversely wrinkled or fluted. Central area pale yellow or pale ochreous, margins broadly white. Ventral scale complete, strongest at the sides, and is often stained bright mauve or pale purple. Exuviæ, at the highest part of the puparium, are generally towards the anterior margin; those of the larvæ are naked and faintly yellow, of the second stage covered with a yellowish secretion. The puparium is decidedly more wax-like in texture than any other species of *Diaspis* I have seen, and is also thick and solid.

Diameter 1·50 to 2 mm.

Adult female (Pl. XV, fig. 16) pyriform. Rudimentary antennæ with a short curved spine. Rostral

filaments short, not reaching the posterior spiracles. Parastigmatic glands, present at each of the four spiracles, number from 3 to 6, the posterior groups having the less number. Spiracles shaped somewhat like those of *Aspidiotus nerii*. Dermis, except the cephalic area, thickly set with short tubular spinnerets, which are most numerous at the margins of the free abdominal segments, and form a very characteristic feature under the microscope. Pygidium (Pl. XVII, fig. 1) short and broad, has the anal opening a little anterior to the centre. Circumgenital glands absent. There are a number of very short, broad, dorsal, tubular spinnerets somewhat irregularly placed, except at the extreme margin, where they are usually arranged in 3—4 pairs, and there is one placed in the centre just within the median plates. The characteristic features of the margin (Pl. XVIII, fig. 4) are the long, stout, bifurcated plates, of which there are two short ones between the median lobes, and one anterior to the latter and the first and second lobes; these three are longest and most constant in character; beyond them are seven to eight others, more or less spine-like, and suddenly dilated towards the base. Median lobes, divergent, are widely separated at the base, and finely and widely serrate on the inner lateral free margin; the second and third pairs are divided; each of the posterior lobules being much the largest, are usually broadly rounded, and have the margins entire or faintly notched, while the anterior lobules are either of a similar character or, as is often the case, pointed and like broad angular spines. The fourth lobe is either rounded or angular, and is sometimes wanting; there are three to four projecting pores, the first and second immediately anterior to the second and third bifurcated spines. The others are beyond them, and usually less pronounced.

Male unknown in any stage.

Larva, short ovate, has six subequal joints to the

antennæ; formula (3, 6) 2, 1, 4, 5. The moult is effected in the same way as in typical *Diaspis*.

Pending the discovery of the male puparium I have followed Mr. Morgan, and placed this somewhat abnormal species in this genus.

Habitat.—On *Cycas revoluta* at Harrow (O'Brien). Quite recently Mr. Watkins has sent me this species on various species of palms from Clevedon. *Cycas revoluta* appears, however, to be its favourite food-plant, and Dr. Leonardi says it is abundant on this plant in Italy, presumably under glass. My description is from specimens from the collection of Mr. J. W. Douglas.

Explanation of the Plates.

Pl. XV, fig. 14.—Insects natural size *in situ* on leaf of Cycas.

Fig. 15.—Puparium of adult and immature female. × 15.

Fig. 16.—Adult female after treatment with potash. × 45.

Fig. 17.—Spiracles and glands of adult female. × 600.

Pl. XVII, fig. 1.—Pygidium of adult female. × 250.

Pl. XVIII, fig. 4.—Margin of pygidium of adult female. × 600.

Genus Aulacaspis (Cockerell).

Aulacaspis was separated by Cockerell from *Diaspis* to include such forms as *D. rosæ*, *D. boisduvalii*, *D. bromeliæ*, and all such species as possess a "very strongly tricarinate" male puparium. A study of the salient characters of the adult female of the species here enumerated shows the division to be a most un-

natural one, as a glance at the illustrations of the pygidia (Pl. XVI, figs. 1—3; Pl. XVII, figs. 2, 3) will show. I have already dealt with *Diaspis*, so that I need not again refer to that genus more than to say that *D. boisduvalii* and *D. bromeliæ* may be considered typical of the genus. The remaining British species in Cockerell's division is *Aulacaspis* (*Diaspis*) *rosæ*, and I have added *A. pentagona*. A careful study of these convinces me that their relation is with *Chionaspis* and *Poliaspis*. In the general character of the pygidium they closely resemble the latter, especially in the form and arrangement of the dorsal tubular spinnerets. These organs have hitherto received but little attention, but I feel confident they are quite as important as the grouped circumgenital glands which have played so great a part in the separation of species.

The species may be separated by the following characters:

A. Pygidium with five groups of circumgenital glands.

a. Lateral groups almost continuous; median lobes with inner margins only free.

(I) . . . . ROSÆ.

b. Lateral groups well separated; median lobes with both margins free.

(II) . . . . PENTAGONA.

AULACASPIS (DIASPIS) ROSÆ (Bouché).

(Pl. XIV, figs. 1—13; Pl. XVII, fig. 2; Pl. XVIII, figs. 5, 7.)

Aspidiotus rosæ, Bouché; Naturgesch. d. schädl. und nützl., Garten-Insecten, p. 83, 2, 1833; *id.*, Nat. der Insecten, p. 14, 2, pl. i, fig. 6, 1834.

Diaspis rosæ (Sandberg), Signoret; Essai, p. 123, pl. v, figs. 3 et 3 *a*.

Diaspis rosæ (Bouché), Douglas; Ent. Mo. Mag., vol. xxiv, p. 23, 1887.
Aulacaspis rosæ (Bouché), Cockerell; Journal Inst., Jamaica, vol. i, p. 180, 1893.

Puparium of the female (Pl. XIV, figs. 2, 3) opaque white; subcircular, widely ovate or broadly pyriform, and convex. Larval exuviæ either just within the margin or projecting beyond it, but when overcrowded frequently subcentral; colour pale to dusky yellow; second exuviæ yellow, orange-yellow, or yellowish brown; secretionary covering white, thin, and transparent. Ventral scale a thin white secretion upon the plant.

Diameter 2 to 2·50 mm.

Puparium of second-stage female (Pl. XIV, fig. 5) broadly pyriform, with the exuviæ terminal.

Adult female immediately prior to parturition (Pl. XIV, fig. 4) elongate, widest in front where it is broadly rounded; segmentation unusually pronounced; free abdominal segments above with a large marginal and submarginal depression. Colour dull orange-crimson; pygidium bright orange. Circumgenital glands covered with a patch of white secretion. Pygidium (Pl. XVII, fig. 2) very large. Circumgenital glands in five groups; the anterior group clearly defined, but the lateral groups are practically continuous. A study of twenty-four individuals shows there is great variation in the number of the spinnerets; the anterior group consists of 11—33; the anterior laterals of 17—40; the posterior laterals of 14—40. Formula of twelve examples:

22	19	6, 14	15	13	32
17—22 . 39—31		34—28 . 33—33		24—26 . 28—37	
39—34 . 30—32		24—27 . 42—30		31—26 . 29—18	
13	33	15	14	14	15
23—27 . 26—31		35—30 . 23—27		22—25 . 16—25	
26—26 . 40—31		38—29 . 28—31		22—21 . 22—23	

On the dorsum are three equidistant bands of short tubular spinnerets, extending from the extreme margin, and almost meeting at the centre, forming incomplete arches. On each side the median line are four to six long, slender, tubular spinnerets, which extend almost to the vaginal opening, and are connected to a corresponding number of dorsal pores opening in a longitudinal series towards the margin. Median lobes very long, widely divergent, but almost touch at the base; inner margin finely serrate, apex scarcely free; second pair of lobes divided and separated so as to appear as two distinct lobes; the third pair are also separated, laterally very broad but extremely short, and are often completely hidden by two projecting dorsal pores. Plates large and spine-like; the first and second immediately precede the median and second lobes, and there are usually four others disposed along the margin. Marginal tubular spinnerets usually number about seven, but the connecting marginal pores do not project far beyond the margin, and their apices are widely rounded. There is a pair of spines between the median lobes; one on each surface of the outer lateral margin of the median lobes, and a pair near the third plate, and several beyond.

Puparium of the male white; strongly tricarinate, central carina usually the strongest. Exuviæ varying from very pale yellow to brown.

Long. 1 mm.

The second-stage male resembles the young female; is of a bright orange-yellow colour.

Pupa pale orange to orange-red.

Male (Pl. XIV, fig. 7) bright orange-red or orange-crimson; abdomen with a pale purplish tinge at the sides; legs and antennæ paler; wings hyaline. Eyes and ocelli black. Antennæ with long slender hairs; apex of apical joint with a long terminal clubbed hair, a short, broad, angular spine, and two fine spine-like processes opposite it (Pl. XIV, figs. 8, 8 *a*); both the position and number of the three latter vary consider-

ably, as seen under the microscope, but this is undoubtedly due to the position of the antennæ under the covering-glass. Legs (Pl. XIV, fig. 9) hairy; digitule to claw and those of the tarsi faintly clubbed.

Larva (Pl. XIV, figs. 10, 11) pale red to dull crimson. Antennæ (Pl. XVIII, fig. 7) of five joints, the fifth being longer than the rest together. Formula 5, 1, 3, 2, 4.

Ova translucent crimson (Pl. XIV, fig. 3).

Habitat.—Chiefly on the wild rose (*Rosa canina*, L.), but has also been found on bramble (*Rubus* sp.). It loves a sheltered hedgerow, and almost invariably infests the stems and thicker branches of its food-plant. Owing to this habit it is frequently carried with the "standard briars" to our nurseries, and thus, inadvertently, becomes a serious pest to cultivated roses, especially those under glass.

In 1887 Mr. J. W. Douglas recorded it from Exeter on *Rosa canina* and *Rubus* sp. Mr. E. E. Green also found it upon the same plants at Bearsted, Kent. In Cheshire it is, next to *Mytilaspis pomorum*, the commonest of the indigenous Coccids, it being especially abundant in the Chester and Knutsford districts. I have received it in abundance from Dover (B. Tomlin), Monellan, Killy Gordon, Ireland (Nicholson), and find it common near Gloucester. It appears, however, to be restricted in its distribution; and I have failed to find it in the north-west district of Leeds; at Orpington and Chislehurst, in Kent; at Hunstanton, Heacham, Snettisham, Ingoldisthorpe, Sedgeford, and Sandringham, in Norfolk, or at St. Albans; and both my friend Mr. A. T. Gillanders and myself have found no trace of it on any part of the vast estate of the Duke of Northumberland at Alnwick.

Distribution.—Probably a European species, but is found almost everywhere on cultivated roses.

Life-history.—Egg-laying commences in August, and the larvæ appear soon afterwards, but are most abundant in the middle of September, and may then be found in a more or less active condition. Before winter

sets in the male larvæ effect their first moult, and a small portion of the puparium is formed (Pl. XIV, fig. 13); but the female larvæ do not moult until the following spring, and may be found throughout the winter either permanently fixed or active even during severe frosts. In early spring the male puparium is completed; subsequently pupation takes place, and the perfect males may be looked for from the middle to the end of May, the time of appearance varying according to the season. In 1896 the males swarmed on the 19th of May. The final moult of the female is effected either immediately prior to or after fecundation, at which stage the puparium is small and decidedly like a Chionaspis (Pl. XIV, fig. 5). By the end of summer it is completed, and will then be found to contain its imprisoned female, together with her batch of pale crimson eggs; later, in winter, her dead shrivelled body and the white, effete egg skins, with an occasional larva. Mr. Green obtained males in August, 1895, but this was probably a case of retarded development. I am quite confident that the wild colonies under observation in Cheshire and Gloucestershire undergo their transformations as already stated, and are single-brooded.

Explanation of the Plates.

Pl. XIV, fig. 1.—Insects natural size *in situ* on branch of wild rose.

Fig. 2.—Puparia of adult female (dorsal). × 15.

Fig. 3.—Puparium of adult female, ventral view disclosing female and eggs. × 20.

Fig. 4.—Adult female prior to parturition. × 35.

Fig. 5.—Puparium of second-stage female at period of fecundation. × 20.

Fig. 6.—Puparium of male. × 20.

Fig. 7.—Male. × 30.

Fig. 8.—Apical joint of antenna of male. × 500.

Fig. 8 *a*.—Another view of apex of antenna of male. × 600.
Fig. 9.—Tarsus and claw of male. × 500.
Fig. 10.—Larva escaping from egg. × 60.
Fig. 11.—Fully-developed larva. × 60.
Fig. 12.—Fully-developed larva showing change of colour immediately prior to first moult. × 50.
Fig. 13.—Commencement of male puparium immediately after larval moult. × 50.
Pl. XVII, fig. 2.—Pygidium of adult female. × 250.
Pl. XVIII, fig. 5.—Margin of pygidium of adult female. × 600.
Fig. 7.—Antenna of larva. × 600.

AULACASPIS (DIASPIS) PENTAGONA (Targioni-Tozzetti).

(Figs. 19, 20.)

Diaspis pentagona, Targ.-Tozz., Bull. Soc. Ent. Ital., 1887, p. 184.
Diaspis amygdali, Tryon, Rep. on Insect and Fungus Pests, 1889, p. 89.
Diaspis lanatus, Morgan and Cockerell, Journal Inst. Jamaica, 1892, p. 136.
Diaspis patelliformis, Sasaki, Bull. Agric. Coll., Imp. Univ. Tokyo, Japan, 1894, vol. ii, p. 107.

Puparium of adult female (Fig. 19, B) approximately circular, or ovate, convex, opaque, white, and frequently mixed with the epidermal tissues of the plant. Exuviæ towards, or at the margin, in front, but not projecting.

Puparium of early adults or second-stage females circular, or broadly pyriform, with the exuviæ at the margin of a bright orange-yellow.

Diam. 1·75—2·75 mm.

Adult female yellow, short ovate or broadly pyriform, gradually narrowed towards the posterior ex-

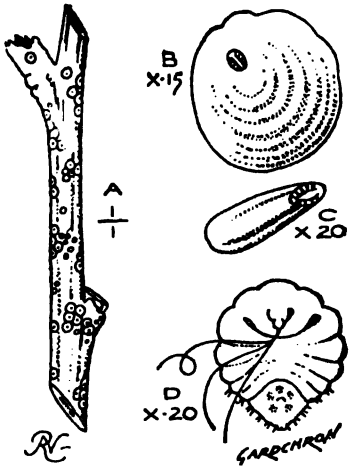

FIG. 19.—Japanese fruit scale, *Aulacaspis pentagona*. A, Insects (nat. size). B, Puparium of the female × 15. C, Puparium of the male × 20. D, Adult female removed from under scale shown at B ('Gardeners' Chronicle').

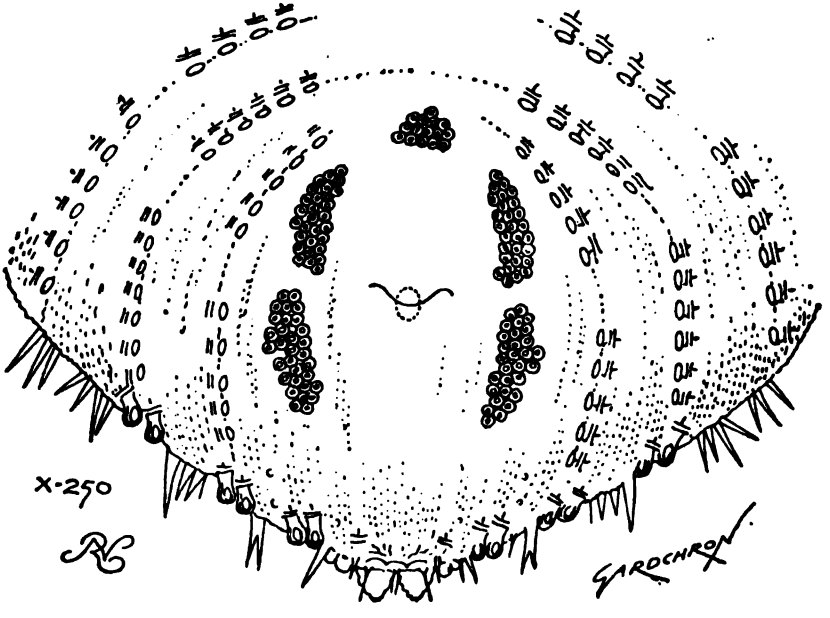

FIG. 20.—Japanese fruit scale, *Aulacaspis pentagona*. Pygidium of the female × 250 ('Gardeners' Chronicle').

tremity. All segments strongly indicated. Rudimentary antennæ narrowly separated; have a single stout hair. Anterior spiracles with fifteen to seventeen parastigmatic glands. Pygidium (Fig. 20) with five large groups of circumgenital glands, which vary considerably in number. Formula of twelve examples:

11	8	13	9	6	10
23—21 .	14—18 .	32—23 .	17—24 .	15—15 .	27—26
19—23 .	17—17 .	21—25 .	17—16 .	15—12 .	28—26
12	13	9	12	7	10
20—21 .	26—29 .	17—16 .	24—24 .	15—18 .	23—21
21—21 .	30—27 .	17—17 .	21—23 .	19—15 .	25—27

Dorsal tubular spinnerets in four subdorsal linear groups, forming two interrupted arches on the lines of the articulation of the segments, and there are similar groups on the succeeding segments. Anal and vaginal openings opposite. Median pair of lobes large, somewhat triangular, with both margins deeply and usually evenly notched; second pair of lobes small, apex rounded and entire. There are three pairs of conspicuous and rounded projecting pores, and a single one between the median and second lobes much smaller, and having a spine-like projection. Plates strong, spine-like, are usually entire, but occasionally they are divided at the extremity; they usually number about twelve on each side of the meson. Spines long and slender, except the median pair, which are minute.

Puparium of the male (Fig. 19, C) faintly tricarinate; white.

Long. ·75—1 mm.

Habitat.—On *Prunus pseudo-cerasus* at the Royal Botanic Gardens, Kew. The specimens were received in March, 1898, with a note from the curator, Mr. G. Nicholson, stating they were imported from Japan upon the above-named plant, which had been out of doors since January of the same year. The plant submitted to me was completely covered with scale,

consisting for the most part of second-stage females in a perfectly healthy condition; there were also a few tenanted male puparia and a number of old adult female puparia which, almost without exception, contained parasitised females. As my description has been made from these latter, the slight variation from typical forms may be due to parasitism.

The existence in England of such an omnivorous pest as this was of a very serious nature, as the species is undoubtedly a hardy one, and I have no hesitation in stating would thrive in this country, and in time become a serious fruit pest. Fortunately the specimens reached me before the larvæ had migrated, and their existence was advisedly cut short. My discovery of this pest happened just at the time of the American fruit-pest scare (March, 1898), when it was supposed the *Aspidiotus perniciosus*, Comstock, had either established itself in this country, or would probably do so from imported fruit (see also pp. 24—28).

Distribution.—Australia, Fiji, British West Indies, Ceylon, North America, where it is said to be double-brooded, and in Southern Europe it is a great pest to the mulberry. Hempel recently records it from Brazil.

Genus POLIASPIS (Maskell).

Here the form of the female puparium is more or less pyriform, as in *Chionaspis*. But the distinguishing features are the *non-carinated puparium of the male;* and in the pygidium of the female possessing more than five groups of circumgenital glands with the dorsal tubular spinnerets arranged in distinct serial bands as in *Aulacaspis*.

POLIASPIS CYCADIS, Comstock.

(Pl. XV, figs. 1—8; Pl. XVII, fig. 3; Pl. XVIII, fig. 6.)

Poliaspis cycadis, Comstock; Report, 1883, p. 116, fig. 15.

Puparium of adult female (Pl. XV, fig. 2) white, or ochreous white; elongate and widened posteriorly, widely pyriform or mytiliform. Exuviæ terminal; those of the larva naked are of a brownish yellow, or pale ochreous; second exuviæ covered with a thick white secretion. Ventral scale white.

Some of the examples from Mr. Douglas' Collection (Pl. XV. fig. 3) were quite hidden beneath the layer of red woolly filaments of the plant; but these were not firmly attached to the secretionary matter as foreign substances usually are.

Long. 2—3 mm.

Adult female (Pl. XV, fig. 5) elongate ovate; extremities equally rounded. Rudimentary antennæ, rather longer than usually found in the *Diaspinæ*, have one or two long curved spines. Anterior spiracles (Pl. XV, fig. 8) with a long cylindrical stem suddenly and widely dilated at apex, which has three to five spinneret-like glands; the parastigmatic glands usually number about twelve. Posterior spiracles (Pl. XV, fig. 7) slender, dilated at base and apex, the latter reniform; parastigmatic glands varying from four to six. The dermis at the sides with large tubular spinnerets and conical spines, numerous on the free abdominal segments, but gradually diminishing towards the cephalic segment, where they are almost wanting. Pygidium large and clearly defined; has eight groups of circumgenital glands, of which the three anterior are additional to the five groups usually found in the

Diaspinæ (Pl. XVII, fig. 3); the three anterior groups each consists of from 2—4 glands; are arranged in the form of a semicircle; the sub-anterior group also consists of 2—4; the anterior laterals of from 10—13; and the posterior laterals from 21—25. My series is much too small to give a correct average of the number of glands, but I gather from Comstock's description that they are not subject to great variation. Dorsal tubular spinnerets, short and cylindrical, are in eight distinct series, forming two incomplete, ellipsoidal arches, the first embracing the five superior groups of circumgenital glands; the remaining four groups completing the second arch. The preceding segment has also a series of 7—8 tubular spinnerets placed near the articulation, and there are 7—8 others of similar character, but smaller, arranged along the margin. Anus opposite the sub-anterior group of glands. Vaginal opening in the centre of the space between superior groups. The median lobes (Pl. XVIII, fig. 6) are large, slightly divergent, usually finely and widely serrate or entire; the second pair of lobes are small, and have the margin widely rounded; third pair usually obsolete or very minute. Comstock (*l. c.*) says the second lobes are divided, but I do not find this character in my examples. The plates are simple and spine-like; there are three between the median lobes and the first series of tubular spinnerets, and one between the latter and the next series, which are much the largest; the rest of the margin has about seven others, much shorter, and with suddenly dilated bases. Spines short; there is one on each side of the median and second lobes, and one near the third and fourth plates.

Puparium of the male (Pl. XV, fig. 4) elongate, is either straight or curved, and non-carinated, and composed of a white felted material as in *Chionaspis*. Larval exuviæ pale yellow.

Long. 1—1·25 mm.

Perfect male unknown.

Habitat.—On *Cycas revoluta* at the Royal Botanic Gardens, Kew.

Distribution.—Chiefly confined to cultivated palms in Europe and in the United States of America, but so far as I have been able to ascertain is not an abundant species.

Explanation of the Plates.

Pl. XV, fig. 1.—Insects natural size *in situ* on portion of leaf of *Cycas*.
Fig. 2.—Puparium of adult female. × 15.
Fig. 3.—Puparium of immature female with plant filaments attached. × 15.
Fig. 4.—Puparium of male. × 20.
Fig. 5.—Adult female after treatment with potash. × 45.
Fig. 6.—Rudimentary antennæ of adult female. × 600.
Fig. 7.—Posterior spiracles, and glands of adult female. × 600.
Fig. 8.—Anterior spiracles of adult female. × 600.
Pl. XVII, fig. 3.—Pygidium of adult female. × 250.
Pl. XVIII, fig. 6.—Margin of pygidium of adult female. × 600.

Genus Chionaspis (Signoret).

The form of the female puparium is elongate, and either pyriform or mytiliform, with the exuviæ at the anterior extremity. That of the male is elongate, tricarinate, and composed of a close white felting, with the larval exuviæ terminal. The second exuviæ are invariably covered by secretion. The puparia in both sexes of *Chionaspis salicis* are typical of the

genus. In *C. brasiliensis* the female puparium resembles *Mytilaspis*, but that of the male is normal in every respect. *C. biclavis* is a doubtful and abnormal species. It may be found necessary hereafter to separate it from typical *Chionaspis*, and place it in the newly erected genus *Howardia* of Leonardi. In the present arrangement I have thought it advisable to retain it in this genus, and in doing so have followed Mr. E. E. Green.*

Synopsis of Species.

A. Pygidium with five groups of circumgenital glands.

a. Puparium of female white.

(I) . . . . . Salicis.

b. Puparium of female brown.

(II) . . . . . Aspidistræ.

B. Pygidium without grouped glands.

a. Puparium formed beneath epidermal layer of branch or leaf.

(III) . . . . . Biclavis.

Chionaspis salicis (Linnæus).

(Pl. XIX, figs. 1—9; Pl. XXII, fig. 1; Pl. XXVII, fig. 2.)

Coccus salicis, Linnæus; Syst. Nat., X, vol. i, p. 456, 1758.

Coccus saliceti, Ratzeburg; Forst. Ins., vol. iii, p. 195, 1844.

Aspidiotus salicifex, Amyot (Cooley); Monom., p. 480, 1847.

* 'Coccidæ of Ceylon,' p. 153.

Aspidiotus minimus, Barensprung (Cooley); Zeit. für Zool., p. 168, 1849.
Chionaspis vaccinii, Bouché; Stett. Ent. Zeit., xii, p. 111, 1851.
Aspidiotus populi, Bouché (Cooley); Stett. Ent. Zeit., xii, 110, 1851.
Chionaspis alni, Signoret; Ann. Soc. Ent. Fr., ser. 4, vol. ix, p. 443, 1869; Essai, p. 125.
Chionaspis fraxini, Signoret; Ann. Soc. Ent. Fr., ser. 4, vol. ix, p. 448, 1869; Essai, p. 127.
? Aspidiotus salicis-nigræ, Walsh (Comstock); Report State Ent. of Illinois, p. 40, 1868.
Chionaspis furfurus, Morgan; Ent. Mo. Mag., s. s., vol. iii, p. 16, 1892; *nec* Fitch.
Chionaspis sorbi, Douglas; Ent. Mo. Mag., s. s., vol. iv, p. 130, 1893.

Puparium of adult female (Pl. XIX, figs. 2, 2 A) white, sometimes faintly tinged with yellow, which gives it a wax-like appearance. Usually widely pyriform, but is often irregular, and sometimes almost circular, but in all cases it is suddenly attenuated at the anterior extremity. Larval exuviæ colourless, or with the deeper parts dark ochreous. Second exuviæ elongate, often project beyond the margin, and are ochreous brown, with the posterior extremity dull yellow; secretionary covering very thin. Sometimes there is an admixture of the dermal tissues of the plant (fig. 2 A), and in late autumn and winter the puparia become so darkened by the accumulation of dirt and *Protococci* that they harmonise with the colour and texture of the plant; this is especially noticeable on young sapling ash.

Long 1·50—2·25 mm.

Adult female (Pl. XIX, fig. 4; Pl. XXI, fig. 11) elongate ovate; cephalic, thoracic, and abdominal segments strongly defined, the former being distinctly trilobate. Colour dull crimson, cephalic extremity dull orange mottled with crimson, pygidium bright

orange; the dorsal spinnerets indicated by a double, semi-elliptic series of dull crimson marks. Eyes black. Rudimentary antennæ normal. Each of the three free abdominal segments with about nine large tubular spinnerets at the margin, of the same character as those of the pygidium; and the last segment presents a few stout, spiny plates. Pygidium (Pl. XXII, fig. 1) with five large groups of circumgenital glands, which vary considerably in numbers, as will be seen by the following formula taken from seven examples on willow:

13	14	14	15
37—21 .	30—28 .	32—27 .	33—32
29—29 .	31—24 .	27—23 .	27—21

15	16	23
35—21 .	38—40 .	38—33
30—30 .	31—27 .	26—33

Dorsal tubular spinnerets, short and cylindrical, are in twelve distinct series, forming three incomplete arches. Within the first series, and immediately behind the lateral circumgenital glands, are usually three other tubular spinnerets. Anus and vaginal opening opposite. The median and second pair of lobes (Pl. XXVII, fig. 2) are well developed; the former have the margins rounded, or faintly and roundly serrate or dentate; the second pair are bilobed, the anterior lobule very small, and both have the margins rounded; third pair are also divided or bilobed, the posterior lobule usually dentate, the anterior lobule very minute, and sometimes both are wanting. There is a spine-like projecting pore between the median and second lobes; an angular one immediately posterior to the third lobe, and there is a third midway between the latter and the last group of plates. Two long spines at the base of the anterior lobule of the second pair of lobes, and another in a similar position at the third lobes. Of the plates there is a short one between the median and second lobes; six others, long and

spine-like, are arranged in three pairs, and followed by a group of four or five others.

Long. 1—1·25 mm.

Immature female at period of fecundation (Pl. XIX, fig. 5) short ovate, slightly narrowed behind; segmentation faint. Colour dull orange-yellow; margin of pygidium bright reddish crimson. At this stage the puparium is narrowly pyriform (Pl. XIX, fig. 3), and consists chiefly of the exuviæ of the second-stage female, which are of a dull madder-brown, covered by a thin white secretion. Larval exuviæ pale yellowish brown.

Puparium of the male (Pl. XIX, figs. 6, 7) white, strongly tricarinate; larval exuviæ as in the female.

Long. ·50—1 mm.

Winged male (Pl. XIX, fig. 9) dark crimson, orange-crimson, or bright orange-red; antennæ and legs bright yellow. Stylus glassy and longer than abdomen. Apodema, a little paler than the rest of the body, is not at all conspicuous. Wings hyaline.

Apterous male (Pl. XIX, fig. 8) coloured, as the winged form, from which it differs only in the absence of wings and halters.

Larva and ova dull reddish crimson.

Habitat.—Abundant on alder (*Alnus glutinosa*), willow (*Salix*, spp.), and ash (*Fraxinus excelsior*), throughout Cheshire, and in many parts of North Wales. Common also near Leeds, Gloucester, and at Stratford-on-Avon (Hodges), London district (Dr. Wiltshire and Mr. Nicholson); in Norfolk, near King's Lynn, and Briston; in Kent, at Bearsted (Green), and near Orpington. In the last district I found this insect a much more general feeder than I had anticipated. In the roadside hedges it was abundant on *Ulmus campestris*, *Euonymus europæus*, *Viburnum lantana*, and *Acer campestre*. On the first-named plant I could, for long time, only detect the male puparia, which were conspicuous by their numbers; but by a careful examination of the branches with a lens the female

puparia were found almost completely hidden in the narrow characteristic crevices of the bark, by which they were thus beautifully protected from the searching eyes of insectivorous birds. In such situations the character of the puparium is greatly altered by contact with the narrow walls of its habitat, and assumed a narrowly elongate form of an almost uniform width throughout, thus affording one of the most interesting instances of adaptation to environment that I have yet seen in the Coccidæ. It is also met with occasionally upon privet (*Ligustrum vulgare*), guelder rose (*Viburnum opulus*), birch (*Betula alba*), broom (*Cytisus scoparius*), *Ribes sanguineum*, poplar (*Populus*, sp.), lime (*Tilia*, sp.) (Douglas), lilac (*Syringa*, sp.).

Distribution.—Has been met with as far north as Ilmola, Finland, in 63° north latitude (Reuter, in lit.); is common in many parts of Southern and Western Europe. In Bohemia (Sulc) and Switzerland it occurs freely on *Vaccinium*, on which plant Mr. Brockton Tomlin met with it at Courmayeur, at an altitude of about 4000 feet. Comstock has found it in the United States of America.

Habits.—Egg-laying commences about the beginning of August, but the larvæ do not hatch until the following May, and so numerous are they in many instances that for a few days the bark assumes a reddish or rusty appearance. By the middle of June the male puparia are formed, and a few days prior to the escape of the males the pupal skin is cast off, and may be seen near the anal extremity of the puparium. The perfect insect appears soon after this, and may be looked for from the end of June to the middle of July (June 30th, 1896). Like the rest of the male *Diaspinæ*, they emerge from the puparium backwards. Twice has it been my good fortune to see these little creatures make their way into the world. On both occasions the whole of the abdomen and thorax were first protruded, then finally the wings. During the process the latter were pulled completely over the head, and

were transversely folded together, the apex of each touching the *ventral* surface at the base. Immediately the insect had liberated itself the wings were unfolded and placed erect; in this position they remained for a few seconds, during which all trace of the central transverse fold disappeared. The wings then assumed their normal position, lying flat upon the abdomen of the insect.

I have not witnessed the escape of the apterous males, but should imagine they accomplished this much more readily than the winged or alate forms.

There is frequently a great preponderance of males, of which quite two thirds are apterous forms; the latter usually appear first. They are active little creatures, and during sunshine are ever on the move searching for the virgin females. I have never seen the alate forms take to flight except when compelled to do so by being forcibly jerked from the bark, when the flight was rapid for so small an insect. The wings appear to be detrimental to their existence rather than otherwise, as they immediately adhere to the moistened surface of glass, etc., from which they can rarely again liberate themselves. On the other hand, the apterous form can walk over the same surface and seem little impeded in its progress; it is only when the moisture is excessive that they cannot get through it. In searching for the female the stylus, trailing behind, is kept in close contact with the bark, etc., and is apparently used as the principal organ of touch, and as the insect rapidly crosses and recrosses its limited habitat it is probed into every minute crevice with which it more or less accidentally comes into contact. On discovering the whereabouts of a virgin female the stylus, together with the posterior legs, is inserted beneath the posterior extremity of the puparium, which at the period of fecundation is uplifted (Pl. XIX, fig. 3 A). I have seen a male return again and again to the same female, and as many as five of them huddled together around

a single puparium on apparently the most friendly terms. Although the male has a head literally full of eyes, they do not seem to enable it to distinguish the puparium containing the virgin female from those of the old adults of the previous years. Furthermore, a male may often be seen actively engaged in probing its stylus beneath some foreign body, to which it will return several times to repeat its fruitless task.

I have only once met with a colony of parthenogenetic females, and this was in an exposed situation on the limestone escarpment at the Loggerheads, near Mold, Denbighshire, on the ground where *Agrotis ashworthii* has been taken for a number of years. They occurred on a group of young ash plants, which they had almost covered, but a male in any stage was not to be seen; and this is the more remarkable, since they were abundant in other localities at the same time.

The American *Chionaspis furfurus*, Fitch, was recorded as British by Mr. C. F. Morgan (Ent. Mo. Mag., S. S., vol. iii, p. 16). A careful examination of specimens kindly supplied by the author convinces me the specimens are referable to *C. salicis*. The smallness of the male puparia of *C. furfurus*, which Mr. Morgan takes as one of the special characters in the separation of the two species, is unfortunately an unreliable one. I frequently find the male puparia of *C. salicis*, especially those from birch and privet, to be equally small as typical *C. furfurus*.

Explanation of Plates.

Pl. XIX, fig. 1.—Insects natural size *in situ* on branch of willow.

Fig. 2.—Puparium of adult female. × 15.

Fig. 2 A.—Puparia of adult female mixed with epidermal layer of bark. × 15.

Fig. 3.—Puparium of female at period of fecundation. × 40.
Fig. 3 A.—The same in profile with apterous male, showing method of copulation. × 25.
Fig. 4.—Adult female before parturition. × 45.
Fig. 5.—Female at period of fecundation. × 70.
Fig. 6.—Puparium of male showing effete pupal skin cast off by the perfect insect which still remains in the puparium. × 35.
Fig. 7.—The same after the emergence of the male. × 10.
Fig. 8.—Apterous male. × 35.
Fig. 9.—Winged male. × 35.
Pl. XXII, fig. 1.—Pygidium of adult female. × 250.
Pl. XXVII, fig. 2.—Margin of pygidium of adult female. × 600.

CHIONASPIS ASPIDISTRÆ (Signoret).

(Pl. XX, figs. 1—10; Pl. XXI, figs. 9, 10; Pl. XXII, fig. 2; Pl. XXVII, fig. 3.)

Chionaspis aspidistræ, Signoret; Essai, p. 125, pl. vi, fig. 11.
Chionaspis brasiliensis, Signoret; Essai, p. 126.
Chionaspis latus, Cockerell (Cooley); Psyche, vol. vii (Supp.), p. 21; Bull. U.S. Dept. Agric., ser. 4, p. 53.
Hemichionaspis aspidistræ, Cockerell; American Nat., vol. xxxi, p. 592, 1897.

Puparium of adult female (Pl. XX, figs. 3, *a*, *b*) mytiliform or pyriform; semi-transparent, and varying from light yellowish brown to madder-brown. Larval exuviæ naked, colourless, or pale yellow, with bottle-green shadings. Second exuviæ, occupying about one third of the puparium, elongate-ovate, and usually narrowed in front; secretionary covering transparent yellowish brown or reddish brown.

Long. 2·50—3 mm.

Early adult female (Pl. XX, fig. 4) yellow; eye-spots black. Mr. Green says the living female insect is of a dull purple-red colour, which I imagine applies to the old adults. Free abdominal segments very distinct, produced and separated at the margins into the form of large projecting tubercles, which in parasitised individuals (Pl. XX, fig. 5) are even more pronounced. At gestation the dermis becomes highly chitinised, especially at the margins, which preserves its form; it is then of a pale yellowish red, with orange-brown margins; with the circumgenital glands and spiracles covered with white secretion. Parasitised specimens also retain their form, but are much more inflated.

Anterior parastigmatic glands number about twelve, are arranged in small sub-groups; posterior groups, fewer, are placed in a single series. Pygidium (Pl. XXII, fig. 2) broad at the base. Circumgenital glands in five large groups. Formula of four examples:

8	9	7	8
23—21 .	22—18 .	17—18 .	19—19
17—18 .	23—21 .	18—17 .	15—19

Margin (Pl. XXVII, fig. 3) with the median lobes, moderately developed, placed closely together, having their inner lateral margin straight, posterior margin usually trilobed, and sloping off almost to the base of the outer lateral margin. Second and third lobes narrowly separated; the former, the longest, have the posterior margin rounded, and are constricted towards the base. A fourth lobe is sometimes present, but is very minute and quite rudimentary. The first three projecting pores are very pronounced and pointed, then follow two others which scarcely project; but at the sixth the margin forms an angular projection. The seven or eight plates are simple and spine-like, and gradually lengthen as they approach the first free segment; the last four are narrowly sepa-

rated. Marginal tubular spinnerets number about nine on either side of the median lobes; a single isolated example of a similar character is placed a little behind each of the lateral circumgenital glands; intermediate linear group consists usually of three, and the anterior group of about eight. Anus central.

Puparium of the male white and strongly tricarinate; larval exuviæ colourless or faintly yellow.

Long. 1 mm.

Pupa (Pl. XX, figs. 8, 9) pale yellow.

Male (Pl. XX, fig. 10) yellow; eyes and ocelli black; legs and antennæ paler; wings ample; apodema of the same colour as the body, and is only faintly indicated.

Second-stage male (Pl. XX, fig. 7) pale yellow; eye-spots black.

Habitat.—In Cheshire it is common on *Asplenium*, sp., and at the Royal Botanic Gardens, Kew, Mr. Green found it on *Cocos plumosa* and *Heliconia metallica*. Mr. Lovell Reays has also sent it from the London district.

Signoret's types were from France and Brazil. It is common in the West Indies. Mr. Green gives it as common in Ceylon. Maskell records it from Australia and Formosa, and Mr. Cockerell from Japan and California.

Explanation of the Plates.

Pl. XX, fig. 1.—Female insects natural size *in situ* on fern stem (*Asplenium*).

Fig. 2.—Male insects natural size *in situ* on portion of fern leaf (*Asplenium*).

Figs. 3, 3 A, and 3 B.—Female puparia. × 25.

Fig. 4.—Adult female at gestation (dorsal). × 45.

Fig. 5.—Parasitised female (ventral). × 45.

Fig. 6.—Puparium of male (dorsal). × 25.

Fig. 7.—Puparium of male (ventral), disclosing second-stage male. × 25.

Fig. 8.—Pupa (dorsal). × 30.
Fig. 9.—Pupa (ventral). × 30.
Fig. 10.—Male. × 35.
Pl. XXI, fig. 9.—Adult female parasitised. × 45.
Fig. 10.—Adult female (normal). × 45.
(Both figs. 9 and 10 from specimens after treatment with potash.)
Pl. XXII, fig. 2.—Pygidium of adult female. × 250.
Pl. XXVII, fig. 3.—Margin of pygidium of adult female. × 600.

CHIONASPIS BICLAVIS (Comstock).

(Pl. XXI, figs. 1—8; Pl. XXIII, fig. 1; Pl. XXVII, fig. 1.)

Chionaspis biclavis, Comstock; Second Report on Scale Insects, 1883, p. 98.
Howardia biclavis, Leonardi; Rivista di Patologia vegetale, Anno iv, Num. 7—12, p. 348.
Aspidiotus theæ (part), Green; Insect Pests of the Tea Plant, p. 12; Coccidæ of Ceylon, p. 152.

Puparium of adult female (Pl. XXI, figs. 1—5) completely covered by the thin epidermal layer of fibre and scales of the bark or leaf of its food-plant. The yellow larval exuviæ which remain exposed upon the surface, and the slight swellings upon the plant, are the only indications of its presence. Stripped of its borrowed covering (Pl. XXI, fig. 4), the form of the puparium is subcircular, ovate, or ellipsoidal; greyish in colour and faintly stained with yellow; underside pure white. Second exuviæ dull crimson, secretionary covering opaque white. Ventral scale (Pl. XXI, fig. 2) white, complete, is rather stout, and usually adheres to the plant.

Long. 2·75—3 mm.

Adult female (Pl. XXI, fig. 6) after treatment with

potash, pyriform, narrowed behind and broadly rounded in front. Dermis highly chitinised. Segmentation distinct. Rudimentary antennæ (Pl. XXI, fig. 7) usually with three short spines. Rostral filaments short, reaching to centre of thoracic segment. Anterior parastigmatic glands number about seven; posterior groups from 3—7. Pygidium (Pl. XXIII, fig. 1) without circumgenital glands. Dorsal tubular spinnerets are all narrowly cylindrical (Pl. XXI, fig. 8), and have the inner capitate extremity proportionately larger than any other species of British *Diaspinæ;* they are numerous along the margin and submarginal area; there is also a more or less definite band of them extending, divergently, from the base of the median lobes almost to the preceding segment. Median lobes (Pl. XXVII, fig. 1) large, nearly as broad again as long; inner margins approximate at the base, but divergent; posterior margin usually rounded; outer lateral margin, sloping towards the base, is roundly dentate. Second pair of lobes minute and usually bilobate. Third and fourth pairs mere dentate projections of the body-wall; the former consisting of three to four projections, the latter of two. Beyond the ninth plate are five to six similar dentate projections. Two spines accompany the median lobes, one ventral and one dorsal. Plates spine-like; median pair minute; there are two between the median and second lobes; three to four between the latter and the fourth lobe; three longer ones, and a slender spine immediately anterior to the fourth lobe; then follows a group of four to five much larger ones. Each of the three preceding segments bears a group of five to seven still larger ones. Two large, somewhat club-shaped, chitinous thickenings of the dermis extend inwards from the base of the median lobes, forming a distinctive character in this species. On each side of these organs are two to three minute spines.

Mr. Green* describes the colour of the oviparous

* 'Coccidæ of Ceylon,' p. 152.

female as "varying with age. At first creamy-white; median dorsal area afterwards suffused with pinkish purple; later with chestnut-brown, by the deposition of chitinous matter which first appears in definite transverse plates across the meso- and meta-thorax and first two abdominal segments, but afterwards extends over the whole dorsal surface as far as the second abdominal segment. Under surface of older examples dull purplish; the second and third abdominal segments and base of pygidium whitish. Inconspicuous eye-spots can be distinguished in the early adult."

Larva. Antennæ of six joints, of which the last is as long as 2, 3, 4, and 5 together. The first and fifth bear one or two short hairs; the last 7—8 very long ones. Formula 6, 2, 1, 3 (4, 5).

Male unknown in any stage.

Habitat.—Royal Botanic Gardens, Kew, on *Annona muricata* (Douglas); Royal Botanic Society's Gardens on *A. cherimolia.* Mr. Green says "specimens have been found in the conservatories of Ireland."

Distribution.—Prof. Comstock's types were from leaves of plants in the conservatory of the U.S. Department of Agriculture. Mr. Kœble has collected it in the Sandwich Isles; it is injurious in Ceylon (Green); and with the exception of the records from this country I believe it has not been met with elsewhere.

Many species of Diaspinæ possess the power of cutting away the epidermal layer of hairs, woolly filaments, scales, etc., of the plants upon which they live, but the burrowing powers of this species are most remarkable, and I believe not equalled by any other known species.

I have not seen living examples of this insect, and am considerably indebted to Mr. Douglas for his valued gift of British specimens. My series, however, was much too limited for thoroughly illustrating this remarkable species, and I have been obliged to fall

back upon Cingalese material which Mr. Green very generously placed in my hands. The illustrations from exotic examples are duly acknowledged in the descriptions of the plates.

Explanation of the Plates.

Pl. XXI, fig. 1.—Insects natural size on branch of tea plant (Cingalese specimens, ex coll. E. E. Green).
Fig. 2.—Portion of same branch magnified three diameters, showing parasitised, semi-detached, and perfect puparia, indicated thus— ♀ .
Fig. 3.—Puparium of adult female (detached) covered with epidermal layer of bark. × 15.
Fig. 4.—Puparium of adult female (detached) with bark removed. × 15.
Fig. 5.—Puparium of adult female (detached), ventral surface. × 15.
Fig. 6.—Adult female after treatment with potash. × 45.
Fig. 7.—Rudimentary antennæ of adult female. × 600.
Fig. 8.—Tubular spinneret of adult female. × 600.
Pl. XXIII, fig. 1.—Pygidium of adult female. × 250.
Pl. XXVII, fig. 1.—Margin of pygidium of adult female. × 600.

Genus Mytilaspis (Signoret).

The British species are distinguished by the mussel-shaped puparium of the female; but several of the exotic species construct long, narrow puparia, *e. g. M. cordylinidis*, Maskell; *M. ampelodesmæ*, Newstead, etc. The larval exuviæ are terminal; those of the second-stage female are covered by a thick layer of secretion, occupy about one-fourth of the entire puparium,

and may or may not be clearly indicated. Ventral scale complete, can rarely be removed intact; it usually ruptures along the centre. The female usually has five groups of circumgenital glands, and subdorsal, intermediate, and anterior series of tubular spinnerets.

The male puparium closely resembles that of the second-stage female, but is less dilated at the posterior extremity, is convex or flat, and without carinæ; is faintly constricted or hinged towards the posterior extremity, and is composed of the same kind of coriaceous secretion as that of the female. It is never felted as in *Diaspis*, *Poliaspis*, *Chionaspis*, etc.

The perfect male has the prothorax very much produced, which throws the insertion of the wings far back, giving the insect an overbalanced appearance.

Synopsis of Species.

A. Grouped circumgenital glands well separated.
  a. Abdominal free segments rounded.
    (I) . . . . Pomorum.
B. Three anterior groups of circumgenital glands continuous.
  a. Abdominal free segments as in *pomorum*.
    (II) . . . . Ficus.
  b. Abdominal free segments tuberculate.
    (III) . . . . Pinnæformis.

Mytilaspis pomorum (Bouché).

(Pl. XXIV, figs. 1—11; Pl. XXV, figs. 1—9; Pl. XXVI, fig. 2; Pl. XXVII, fig. 5.)

Aspidiotus pomorum, Bouché; Ent. Zeit. Stett., 1851, xii, No. 1, p. 110.

Aspidiotus conchiformis, auctorum; *nec* Gmelin, Syst. Nat., ii, 221.

Mytilaspis pomorum (Bouché); Signoret, Essai, p. 142, pl. vi, fig. 9.

Puparium of old adult female (Pl. XXIV, fig. 4) convex; elongate, widened posteriorly, more or less curved, or when overcrowded frequently contorted. Varies from pale to dark red-brown. Perfect examples farinose, which gives them a greyish appearance. Ventral scale complete; dusky white, or faintly stained pale red; almost invariably ruptures along the centre. Those of the young adults (Pl. XXIV, figs. 3, 5) are light or dark madder-brown, frequently with a faint trace of dark green towards the posterior extremity, where the extreme margin is white or greyish. Ventral surface sometimes with the posterior portion a beautiful dark green. Larval exuviæ dark orange-yellow; paler in cabinet specimens. Second exuviæ of the same colour; secretionary covering thin.

The foregoing description of the old adult puparia is from examples on apple bark; that of the young adult from examples on apple leaves.

Long. 2—3 mm.

Puparium of second-stage female (Pl. XXIV, fig. 6) narrowly pyriform, convex; yellowish or pale reddish brown and farinose. Larval exuviæ orange-yellow.

Long. 1 mm.

Adult female (Pl. XXIV, fig. 5; Pl. XXV, fig. 1) usually translucent white, sometimes a little yellowish, extremity of pygidium orange-yellow; elongated, segmentation distinct; cephalic segment faintly trilobate. Rudimentary antennæ with two to three spiny hairs. Anterior parastigmatic glands from three to six in number. There are no posterior groups, but a little posterior to the spiracles are usually three simple glands. The last two or three free abdominal segments with a few spines. All free segments from base of the thoracic area with numerous tubular spinnerets. Pygidium (Pl. XXVI, fig. 2) with five groups of circumgenital glands, subject to great variation in number.

Formula of fifteen examples from apple:

5	7	8	8	8
15—17 .	13—13 .	13—13 .	15—15 .	14—19
10—12 .	11— 9 .	12—10 .	14—16 .	12—13
8	8	9	10	10
15—17 .	17—17 .	11—13 .	9—11 .	14—11
9—13 .	12—14 .	10—12 .	14—12 .	13—10
10	10	11	12	13
14—11 .	17—16 .	15—13 .	15—17 .	9—17
13—10 .	15—12 .	14— 9 .	10—12 .	12— 8

Formula of six examples from *Cassia* (under glass):

9	9	10	10
16—12 .	18—17 .	17—23 .	18—15
11—14 .	16—12 .	18—12 .	14—18
	11	12	
	19—20 .	17—17	
	13—12 .	14—11	

Dorsal tubular spinnerets, small and cylindrical, are arranged in three series: the first, opposite the lateral ventral glands, form a long scattered band terminating near the anus; intermediate series in a single row forming an incomplete arch, with an outward lateral series extending from the middle almost to the margin; third series following the articulation of the pygidium with the segment. On each side of median lobes along the margin (Pl. XXVII, fig. 5) are six large tubular spinnerets, of which the second and third, and fourth and fifth are arranged in pairs. Anus a little in front of the anterior group of ventral glands. Vaginal opening almost central. Median lobes almost as broad again as long; lateral margins usually straight; posterior margin centrally lobate, with one or two notches on either side. Second and third pairs of lobes small, almost touching, have their margins rounded and entire, or bluntly and irregularly dentate. Plates long and spine-like, usually one median and four lateral pairs.

Male puparium narrowly elongate, sides almost

parallel, slightly widening towards posterior extremity; convex; at about three-fourths from the anterior extremity is a narrow, transverse, curved groove or constriction, which acts as a hinge to allow of the free escape of the male. Exuviæ orange-yellow.

Long. 1 mm.

Male (Pl. XXIV, fig. 8) pale mauve or purple; antennæ and legs (Pl. XXV, figs. 4—7) of the same colour, but the latter are faintly tinged with yellow; thorax and apodema pale brownish yellow, with purplish shadings. Eyes black. Antennæ with four long clubbed hairs on apical joint; all the rest of the hairs are simple and pointed. Wings faintly hyaline; halters with a very long curved bristle. Legs with the tibiæ and tarsi very hairy; digitules slender and faintly clubbed.

Male pupa (Pl. XXIV, figs. 9, 10) pale mauve; legs and antennæ colourless or faintly yellow; ocelli black.

Larva (Pl. XXIV, fig. 11) elliptical; translucent white; extremities yellow. Antennæ of six joints, of which the last is nearly as long as 2, 3, 4, and 5 together; formula, 6 (2, 3), 1 (4, 5). In the newly hatched larvæ the joints of the antennæ are shorter and stouter. Equidistant between the eyes on the ventral surface are two long tubular spinnerets. (see also p. 72, figs. 8—10).

Ova white.

Habitat.—Common everywhere; is a great pest on the apple, and occasionally so on the pear. It loves a warm sheltered situation, and thrives best on a tree occupying a south wall. Is a general feeder, but occurs most freely upon the apple. The following is a list of the food-plants:—Sallow (*Salix*, spp.); *Cotoneaster*, spp. (freely); black and red currant (*Ribes*, spp.); hawthorn (*Cratægus*), broom (*Cytisus*, sp.), *Vaccinium myrtillus*, heath (*Erica*, spp.); *Calluna*, sp.; wild rose (*Rosa*, spp.), mountain ash (*Pyrus aucuparia*), raspberry (*Rubus idæus*), sloe (*Prunus communis*), *Ceanothus*, *Cornus alba*, var. *spaethii*, *Elæagnus argentea*.

A cassia tree in one of the Duke of Westminster's conservatories at Eaton became so badly infested with this insect that it had to be destroyed. To the best of my knowledge this is the only instance known of this pest infesting plants in cultivation under glass.

Habits.—At the end of August and the beginning of September the female lays her eggs, which remain in the puparium through winter. About the middle of May (22nd, 1896) the minute white larva may be seen actively climbing the infested trunks and branches of its food-plant. In about six weeks the male puparium is completed, and the perfect insects make their appearance about the middle of July (17th, 1896). At the period of fecundation the female is very small, and her puparium scarcely larger than that of the male. After fecundation the puparium is greatly enlarged, and completed by the end of August. The absence of males in this species, on certain food-plants, is most remarkable. During nine years of observation I have never seen a single example of the puparium on either the apple, pear, cotoneaster, currant, or hawthorn. And I know of no student abroad who has ever met with this sex in any stage.* Mr. Maskell, who has devoted more time to the study of the Coccidæ than any entomologist, says ('Scale Insects of New Zealand,' p. 52), "Male unknown in New Zealand and Europe, doubtful in America." Here in England, however, I have met with it freely on *Cytisus* and *Vaccinium*, and sparingly on heath (*Erica*, sp.). I shall not forget the pleasure the discovery of the first male gave me. It was in July, 1896, when spending the day at Bearsted, Kent, with Mr. E. E. Green. We had taken a stroll together to a sand-pit in the vicinity of his house, when my friend remarked there were a number of *M. pomorum* on the broom bushes, and on examining a small branch of the plant with a lens I discovered a male entangled

* In the 'Fifth Missouri Report,' p. 95, Riley describes what he considered the male of *M. pomorum*. The curious dilated hairs on the antennal joints clearly show he had quite a different insect before him. Recently Prof. Leonardi has found the male in Italy.

in a spider's web. Alas! it was dead and shrivelled, but a further search revealed a host of the puparia. Cutting a goodly supply of the branches, we found the puparia were tenanted, and during the following week quantities of the perfect insects emerged.

With regard to the synonymy of this species, I have here given priority to Bouché. Mr. Morgan ('Ent. Mo. Mag.,' s. s., vol. i, p. 226), however, gives *M. linearis*, Mod., and quite recently Mr. Cockerell informs me that *M. pomorum* is a synonym of *M. ulmi*, L., and he is probably correct; but I feel that it is not always possible, especially in the Coccid group, with such imperfect descriptions as were given by the earlier writers, to identify a species so surely as to leave no doubt as to the priority of a name. In his synonymy Mr. Morgan (l. c.) has perhaps gone too far, and included species which are still considered valid; otherwise I think he has cleared up many doubtful names, and I must refer the student to his very able paper for further particulars.

Distribution.—Occurs in many other parts of the world generally as a pest on cultivated fruits—Southern Europe, Africa, N. America, Brazil, Australia, and New Zealand.

Explanation of the Plates.

Pl. XXIV, figs. 1 and 2.—Female insect, natural size, *in situ* on branch of apple.

Fig. 3.—Puparium of young adult female (dorsal). × 15.

Fig. 4.—Puparium of old adult female (ventral) showing female and eggs. × 15.

Fig. 5.—Puparia of young adult female (ventral) form on apple leaf, containing female immediately prior to parturition. × 20.

Fig. 6.—Puparium of second-stage female at period of fecundation. × 15.

Fig. 7.—Puparium of male. × 15.
Fig. 8.—Male. × 35.
Fig. 9.—Pupa (dorsal). × 40.
Fig. 10.—Pupa (ventral). × 40.
Fig. 11.—Larva. × 50.
Pl. XXV, fig. 1.—Adult female after treatment with potash (ventral). × 50.
Figs. 2, 3.—Rudimentary antennæ of adult female. × 500.
Fig. 4.—Antenna of male. × 100.
Fig. 5.—Terminal joint of male. × 600.
Fig. 6.—Leg of male. × 100.
Fig. 7.—Tarsus and claw of male. × 600.
Fig. 8.—Halter of male. × 600.
Fig. 9.—Spiracle of male. × 600.
Pl. XXVI, fig. 2.—Pygidium of adult female. × 250.
Pl. XXVII, fig. 5.—Margin of pygidium of adult female. × 600.

MYTILASPIS POMORUM, var. ULICIS (Douglas).

Mytilaspis ulicis, Douglas; Ent. Mo. Mag., 1886, vol. xxii, p. 249; vol. xxiii, p. 152.

Puparium of adult female "dark castaneous" (Douglas, l.c.); cabinet specimens dark madder-brown to almost black. Larval exuviæ dull orange or ochreous. Second exuviæ dark reddish brown. Very convex; narrowest at the portion occupied by the exuviæ; the rest of the puparium usually of an equal width throughout. Straight, curved, or sometimes spiral.

Ventral scale usually comes away intact except at the posterior extremity.

Long. 2·25—3 mm.

Adult female not differing structurally from typical *M. pomorum*.

Habitat.—Mr. Douglas says, "On December 14th, on furze bushes (*Ulex europæus*) growing on the most

open and exposed part of Blackheath, far from any other shrub or tree. I found the scales not uncommon. They were on the young terminal shoots, not on the bark, but closely fitted into the longitudinal grooves of the spines or the narrow hollow of the leaflet at their base, and being of the exact width of their site were not easy to detect. . . . Here and there, however, at the wider part of a spine at its base was a scale somewhat broader behind. On one spine are two scales that had begun at a level point, and for as far as they were only as wide as the larval scale they are side by side, but then one of them having occupied the width of the groove, the other had no resource left but to cross the scale of its rival, which it did, and maintained its position."

In 1896 Mr. Green found this variety fairly common at Sherbrook, Devon, but I have never met with it anywhere. Very dark examples of *M. pomorum* also occur on *Vaccinium myrtillus*, but they are typical in form.

MYTILASPIS POMORUM, var. CANDIDUS (Newstead).

Mytilaspis pomorum, Bouché, var. *candidus*, Newst.; Ent. Mo. Mag., s. s., vol. xii, p. 82, 1901.

Puparium of adult female snow-white, very elongate, of uniform width throughout, and very convex; texture much less horny than typical puparia, and resembling more closely the puparia of *Chionaspis* or *Poliaspis*. Its position was curved round the base of a spine of the food-plant. Female adult not differing from typical *M. pomorum* on apple.

The puparium of this variety shows the most remarkable deviation from the type I have yet seen. It was discovered by Mr. E. E. Green (to whom I am indebted for the specimen) at Halfway Bridge, Petworth, Sussex, September 1st, 1899. He says, "I enclose a single specimen of a *Mytilaspis* with a snowy

white scale, which I found a few days ago on hawthorn here. Do you think it is a distinct species or only a var. of *M. pomorum?* Irrespective of the colour, the texture of the scale appears to me to be rather different."

MYTILASPIS FICUS (Signoret).

(Pl. XXVI, fig. 3; Pl. XXVII, fig. 7.)

Mytilaspis ficus, Signoret; Essai, p. 138.

Puparium of adult female elongate, straight or curved; but narrower and less dilated at posterior extremity than in *M. pomorum*. Pale orange-brown, anterior half dark red-brown or castaneous, posterior extremity paler. Larval exuviæ yellowish-brown or orange-brown; second exuviæ small, shining orange-brown, posterior extremity paler. Secretionary covering dark red-brown; laminæ grey at the edges, and the whole puparium is frequently farinose. Ventral scale complete, but usually ruptures along the centre from end to end on removal from the bark.

Average length 2 mm.

Adult female more elongate and smaller than either of the preceding species. Segmentation resembling *M. pomorum*. Rudimentary antennæ with two slender curved spines. Anterior parastigmatic glands average about three, posterior groups absent. Dermis, from just below the rostrum to last free abdominal segment, thickly set with short tubular spinnerets, with the inner capitate extremity broad as in *Chionaspis bicla ris*. Each abdominal segment at margin with 3—4 short spiny plates, many of which are suddenly dilated towards the base. Pygidium (Pl. XXVI, fig. 3) with five groups of circumgenital glands, of which the three anterior groups are more or less continuous; the anterior group consists of from 4 to 6, are arranged in

a single row as in *M. pinnæformis*. Anterior laterals from 8 to 14; posterior laterals from 7 to 9.

Formula of three examples:

5	4	5
14—10 .	11—9 .	9—8
7— 8 .	7—9 .	6—6

Dorsal tubular spinnerets in three series; subdorsal group consists usually of 8—9, arranged in an interrupted line; the intermediate series consists of about the same number, form two distinct groups, the lesser group being nearest the margin; the anterior group extends within the preceding segment. There are also a series of marginal tubular spinnerets of the same character and arrangement as in *M. pomorum;* but there are four additional long, slender, tubular spinnerets on each side of the meson, which afford an excellent character for separating this species from its allies; the median pair are connected at the margin with the minute plates, as also are the next pair with the second pair of plates. Anus and vaginal opening as in the preceding species. Median lobes (Pl. XXVII, fig. 7) large; lateral margins short and straight; posterior margin outwardly strongly bidentate, inwardly with a single notch, subcentrally lobate; second and third pairs rudimentary. Plates in five pairs, of which the median and second pairs are very small. Dorsal median spines long and stout, and there is one of a similar character between the second and third lobes.

Puparium of the male is said to resemble that of the female, but is smaller and whiter.

Habitat.—Mr. Morgan (Ent. Mo. Mag., 1890, p. 230) says, "I received this species from Mr. Douglas, who received it from the Royal Horticultural Society's Gardens at Chiswick, where it was found on fig trees imported from the south of France fifteen years ago, and kept in pots under glass; the scales were at one time abundant, but careful treatment in brushing and washing them off has nearly extirpated them." My

types are from the same kind source, and I am greatly indebted to Mr. Douglas for them. The species has not been met with elsewhere in England, and does not appear to be very widely distributed on the continent of Europe.

Explanation of the Plates.

Pl. XXVI, fig. 3.—Pygidium of adult female. × 250.
Pl. XXVII, fig. 7.—Margin of pygidium of adult female. × 600.

Mytilaspis pinnæformis (Bouché).

Pl. XXV, figs. 10—12; Pl. XXVI, fig. 1; Pl. XXVII, figs. 4, 6.

Mytilaspis pinnæformis, Bouché; Ent. Zeit. (1851), p. 111.
Mytilaspis pinnæformis (Bouché), Sign.; Essai, p. 141, pl. vi, figs. 4, 8.
Mytilaspis fulva, Targioni-Tozzetti; Catal. (1868), 44.
Aspidiotus citricola, Packard; Guide to Stud. Ins., 1870, 2nd ed., p. 527.
Mytilaspis fulva, Targioni-Tozzetti; Effemeridi del Comizio Agrario di Firenze, 1872.
? *Mytilaspis flavescens*, Targioni-Tozzetti; Ann. del Minist. Agric., Ind., e Commerc., 1876, 36.

Puparium of adult female yellowish brown to dusky brown, or greyish ochreous, paler at the margins; edges of laminæ frequently white; sometimes the whole puparium is faintly farinose; convex, straight, curved, or mytiliform. Larval exuviæ dull yellow to orange-brown; second exuviæ usually of the same colour. Ventral scale complete, usually comes away unbroken. Form not differing materially from *M. pomorum*, but I have never seen the colour so dark as in this latter.

Long. 1·75—2 mm.

Adult female (Pl. XXV, fig. 10) white or yellowish. Very elongate, narrowest in front, widest at first free abdominal segment. Rudimentary antennæ with one or two stout curved hairs. Anterior parastigmatic glands vary from 6 to 9; posterior groups absent, but a little posterior to the spiracle is a group of 3—4. Four free abdominal segments very pronounced, forming, after treatment with potash, tuberculate projections, each furnished with several short spines. Dermis with tubular spinnerets as in *M. pomorum*. Pygidium (Pl. XXVI, fig. 1; Pl. XXVII, fig. 4) with five groups of circumgenital glands; anterior group arranged in a single concave series; anterior laterals usually forming a pyriform group; posterior laterals usually in a more or less circular group.

Formula of six examples:

6	7	5	7	6	7
12—14 .	14—11 .	13—12 .	17—12 .	12—12 .	11—9
8— 9 .	9— 9 .	10— 8 .	9—11 .	7— 9 .	10—8

Anus considerably above anterior grouped glands. Vaginal opening immediately below the posterior lateral groups. Subdorsal groups of tubular spinnerets occupying same position as in *M. pomorum*, but shorter and a little more defined. Seven marginal tubular spinnerets on each side of the centre, very large, the first singly between the median and second lobes; the rest in pairs. Median lobes narrower, more attenuated at the base than in *M. pomorum;* lateral margins sloping and extending within the body-wall, more irregularly dentate or bluntly serrate; posterior margin lobate; second and third pairs of lobes, placed together, have the posterior margin rounded, and sometimes with a faint lateral notch. Plates, one median and four lateral pairs, are simple and spine-like. Margin between the second and third pairs of lateral plates distinctly but irregularly serrate. First marginal pore with a minute spine-like projection.

Male puparium, usually a little paler than that of the female, is of a more delicate structure than that of *M. pomorum*. Hinge towards the posterior extremity.

Male unknown.

Habitat.—First recorded from the Royal Botanic Gardens, Kew, on *Cymbidium pendulum*, by Mr. Douglas. It is strange that both Bouché and Signoret should have found the insect upon the same genus of plants, as it is a lover of *Citrus* trees, and everywhere where they are cultivated the insect seems to become a pest. It also occurs here freely upon imported oranges and lemons.

The female is easily distinguished from *M. pomorum* by the tuberculate segments, the linear anterior group of circumgenital glands, and the form and character of the median lobes. Also by the second-stage female having a spine-like projection on each of the abdominal segments.

Explanation of the Plates.

Pl. XXV, fig. 10.—Adult female after treatment with potash. × 50.

Fig. 11.—Cast skin of second-stage female. × 50.

Fig. 12.—Cast skin of larva. × 100.

Pl. XXVI, fig. 1.—Pygidium of adult female. × 250.

Pl. XXVII, figs. 4 and 6.—Margin of pygidium of adult female. × 600.

Genus Pinnaspis (Cockerell).

According to our present knowledge the generic characters of this genus are only separable from *Mytilaspis* by the comparatively large exuviæ of the second-stage female.

We have no definite knowledge of the male puparium,

as, unfortunately, Signoret's description is not full enough to give us a clear idea of its true character; and I am not at all sure that the puparium hereafter described is the true puparium of the male.

PINNASPIS BUXI (Bouché).

(Pl. XV, figs. 9—13; Pl. XXIII, figs. 2, 3; Pl. XXV, figs. 13, 14.)

Aspidiotus buxi, Bouché; Ent. Zeit., 1851, p. 111.
Mytilaspis buxi, Signoret; Essai, p. 137, pl. vi, fig. 10.
Mytilaspis pandani, Comstock; Rept. U.S. Dept., 1880, p. 324, pl. xx, figs. 1, 2; and Second Report, 1883, p. 118.
Pinnaspis pandani, Cockerell; Journ. Inst. Jamaica, 1892, p. 136.

Female puparium (Pl. XV, fig. 10) generally light or dark red-brown or orange-brown, posterior extremity lighter. Second exuviæ usually of the same colour as the secretionary portion; larval exuviæ sometimes pale yellow. The second exuviæ occupy a little more than one-third of the puparium.

Long. 1—1·50 mm.

Puparium of the Male.—Signoret* describes this as having parallel sides, and of a deep yellow colour. The description is much too brief to give us any clue as to its true character. On Pl. XV, fig. 12, I have figured what may possibly prove to be the puparium of this species, but as I failed to find any of my examples tenanted by either sex, it is possible they may be imperfect puparia of immature females.

Male.—Signoret describes it as yellow with a brown apodema.

Adult female (Pl. XV, fig. 11) very elongate, with

* 'Essai,' p. 137.

the free abdominal segments strongly produced. Colour dull red with pygidium yellow.

Rudimentary antennæ (Pl. XXV, fig. 13), rather longer than is usual in the *Diaspinæ*, have a single curved spine arising from the side. Anterior group of parastigmatic glands (Pl. XXV, fig. 14), small, usually number about three; posterior groups absent. Pygidium (Pl. XXIII, figs. 2, 3) with five groups of circumgenital glands.

Formula:

4	4	4	4	4
10—12 .	10—12 .	11—12 .	10—11 .	9—10
13—12 .	13—12 .	12—13 .	12—11 .	12—11

There are no central groups of dorsal tubular spinnerets, but these organs form a conspicuous feature along the margin; there are usually eight of them on each side of the median lobes, of which the first five are equidistant and rather close together; the rest are more widely separated; all have projecting pores, but the first and second are much more prominent than the rest. Median lobes approximate, small; outer lateral margin irregularly dentate or notched; second pair shaped somewhat like the blade of an axe, but the form varies; third pair obsolete. Plates spine-like, four on each side the median lobes, become longer and stouter towards the preceding segment, the last being much the largest. There is a spine immediately anterior to the second lobes, another near the third plate, and two towards the last plate.

Larva elongate ovate. Antenna of five joints, of which the last is as long as the rest together. Formula, 5, 2, 1 (3, 4); the last joint has 3—4 long hairs.

Habitat.—A serious pest in many places, and most difficult to keep in check. It has occurred on the following plants in the Royal Botanic Gardens, Kew: —*Licuala grandis*, *Dæmonorops* (*Calamus*) *Lewisianus*, *Chrysalidocarpus lutescens*, and more sparingly on *Pandanus conoideus*. I have received it also from the

Botanical Gardens, Dublin (Burbidge), on *Monstera deliciosa*, and from the Botanical Gardens, Liverpool (Gutteridge), on *Kentia*, sp.

Distribution.—In Southern Europe it lives on the box (*Buxus sempervirens*). It also occurs in the United States.

Chrysalidocarpus lutescens, Wend., at Kew, produced a distinct white form, which agrees with Cockerell's var. *albus*. The puparium is transparent white; exuviæ yellow, or orange-yellow to orange-brown. Its form, too, is remarkable, in that many specimens have the sides perfectly straight, and almost parallel. I imagine the alteration in the colour is due to some chemical action on the part of the plant, which affects the secretionary matter, and renders it colourless. Otherwise it is difficult to account for the numerous colonies of this species on other plants in the same house having normal red-brown puparia.

Explanation of the Plates.

Pl. XV, fig. 9.—Insects natural size.

Fig. 13.—The same on portion of palm leaf, showing stains caused by the insects.

Fig. 10.—Puparium of adult female. × 35.

Fig. 11.—Adult female. × 45.

Pl. XXIII, fig. 2.—Margin of pygidium of adult female. × 600.

Fig. 3.—Pygidium of adult female. × 250.

Genus Ischnaspis (Douglas).

A genus remarkable for the length and narrowness of the female puparium, and the peculiar lattice-shaped character on the dorsal surface of the female pygidium (Pl. XXVIII, fig. 7). Another characteristic feature is the possession of only three groups of circumgenital glands (fig. 8).

The larval exuviæ are terminal, and covered by a very thin transparent secretion, which forms equidistant rounded processes all round the margin. These appendages entirely disappear on being boiled in caustic potash.

The male puparium resembles that of the second-stage female, and is from one-fourth to one-third the length of that of the female. It differs from *Mytilaspis* in having no central hinge.

ISCHNASPIS FILIFORMIS (Douglas).

(Plate XXVIII, figs. 1—9.)

Ischnaspis filiformis, Douglas; Ent. Mo. Mag., vol. xxiv, p. 21, figs. 1—3, 1887.

? Mytilaspis longirostris, Signoret; Bull. Soc. Ent. France, 1882, p. xxxv.

Puparium of adult female (figs. 2, 3) very long and narrow, about eight times longer than broad; sides parallel, posterior extremity very slightly broadest; very convex; shining black, margins greyish. Larval exuviæ orange-brown, central area with a rich castaneous blotch; cabinet specimens pale, dull yellow, with the central blotch or blotches rusty brown; secretionary covering thin and transparent, forming at the sides a series of equidistant rounded projections; second exuviæ, occupying about one-fourth of the puparium, covered with a dense black, shiny secretion, like the remainder of the puparium. Ventral scale (fig. 3) complete, thick, white or greyish, with yellow stains; it generally comes away unbroken from the food-plant.

Long. 2—3 mm.

Adult female (figs. 5, 6) very elongate; sides parallel; broadest at the free abdominal segments; the latter, together with the pygidium, only occupy about one-eighth of the entire length of the insect. Colour

pale, or bright yellow, sometimes with a faint trace of orange. The female only occupies a small portion of the puparium. Rostral filaments extending to about the middle of the body. Pygidium short, broad, and widely rounded; median lobes and first two plates within a broad, shallow emargination; dorsal area (fig. 7) almost covered with an irregular lattice-work design, formed apparently by the thickening of the dermis, the outer anterior walls of which are symmetrically branched. Anus a little below the centre. Midway between the anus and the margin on each side are one or two circular glands, in character resembling those of the ventral surface. Circumgenital glands in three groups (fig. 8); the anterior group consisting of 3—4, the posterior laterals of 4—6: the former group is placed immediately opposite the anal opening; the latter group a little below it, and opposite the first marginal projecting pore. Median lobes well developed, are widely separated, and have their margins broadly and evenly rounded, and finely serrate; second and third pairs small, placed closely together, are of a similar shape to the median pair, but the serrations are absent. Between the median and second pair of lobes is a spine, two spine-like plates, and a large, blunt, projecting pore; there is a spine over the third lobes, which is followed by a third plate; equidistant between the latter and the fourth plate is a second marginal projecting pore, less pronounced than the first; on the rest of the margin beyond are 4—6 equidistant plates, and about the same number of small spines.

Puparium of the male (fig. 4) elongate; sides resemble the anterior portion of the female puparia both in colour and form; and the character of the larval exuviæ does not differ.

Long. 1 mm.

Male unknown.

Habitat.—Mr. Douglas (l. c.) says it is "abundant in the conservatories of the Royal Botanic Society on the leaves of various palms, *Strychnos*, *Myristica*, and other

plants, looking like little bits of silk thread accidentally affixed." I have also met with it sparingly on various palms in the conservatories of the Duke of Westminster at Eaton, Chester, and have received it from the Royal Botanic Gardens, Kew, on *Diospyrus discolor;* from the Botanical Gardens, Dublin (Burbidge), on *Ficus*, sp.; and from Scotland and the Midlands on *Anthurium*, sp.

It appears, therefore, to have become pretty generally distributed, and being a difficult species to destroy will probably spread.

Distribution.—Common on coffee at Lagos, W. Coast Africa; is plentiful in the West Indies, and also in Brazil.

Explanation of the Plate.

Pl. XXVIII, fig. 1.—Insects, natural size, *in situ* on portion of palm leaf.

Fig. 2.—Puparia of adult female (dorsal). × 25.

Fig. 3.—Puparium of adult female (ventral). × 25.

Fig. 4.—Puparium of male. × 25.

Fig. 5.—Adult female.

Fig. 6.—Adult female after treatment with potash. × 70.

Fig. 7.—Pygidium of adult female (dorsal). × 250.

Fig. 8.—Pygidium of adult female (ventral). × 250.

Fig. 9.—Moulted skin (exuviæ) of larva showing tubercles formed of secretionary matter at margin.

Errata.

Page 51, lines 4 and 11 from bottom, for *Orthesia* read *Orthezia*.

Page 81, line 17 from top, for BROMILIÆ read BROMELIÆ.

Page 86, top line (repeated), for *bromiliæ* read *bromeliæ*.

Page 124, line 19 from bottom, for *cyanophyli* read *cyanophylli*.

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Zosterops lateralis, ? eating Lecanium hesperidum, 33

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PLATE A.

EXPLANATION OF PLATE A.

Fig. 1. TACHARDIA LACCA, natural size. (Page 16.)

In the two lower figures the "lac" is seen *in situ* attached to the branches where the female insects secreted it. The circular specimen to the right is a cross-section of a similar specimen, showing the hollow branch in the centre, and the radiating pyriform cells or chambers which in life were tenanted by the female insects.

Fig. 2. CRYPTOCOCCUS FAGI. (Pages 29 and 41.)

The white patches of felted matter in the crevices of the bark are the ovisacs of the females. It is a very common species, and sometimes the sacs completely cover the bark. It is given here as an illustration of one of the British Coccids not known to be attacked by birds, and very rarely by insect parasites, and is very probably a nauseous species. (For similar insects see also Plates C and E.)

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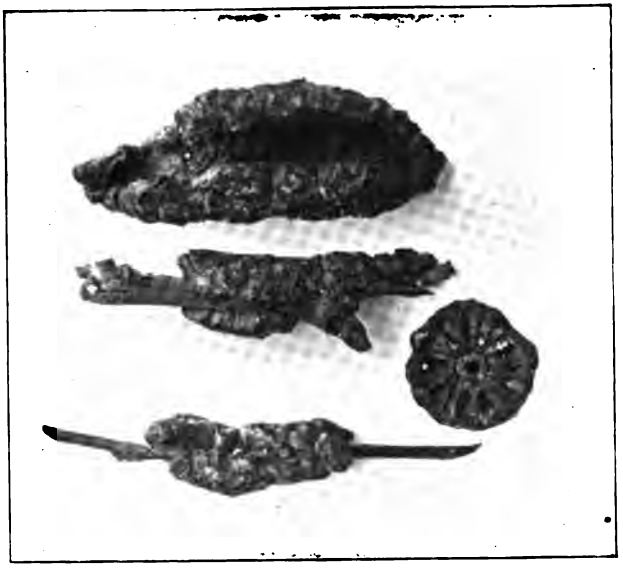

FIG. 1.—LAC INSECT *(Tachardia lacca)*.

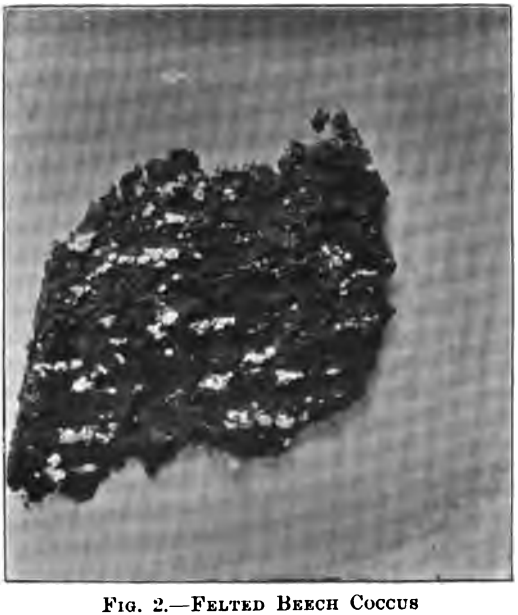

FIG. 2.—FELTED BEECH COCCUS
(Cryptococcus fagi) on Beech bark (nat. size).

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E. Newstead, photo. Adlard & Son, Imp.

PLATE B.

EXPLANATION OF PLATE B.

Fig. 1. ASPIDIOTUS PERNICIOSUS. (Page 25.)

This species is the most destructive of all the members of the Diaspinæ. The illustration is given to show the remarkable similarity between it and our common *A. ostreæformis* (fig. 2). Structurally the two insects are very different, but the salient characters of each cannot be seen without proper preparation (see p. 48) and microscopic examination of the insects, which are hidden beneath the scales or puparia.

Fig. 2. ASPIDIOTUS OSTREÆFORMIS. (Page 99.)

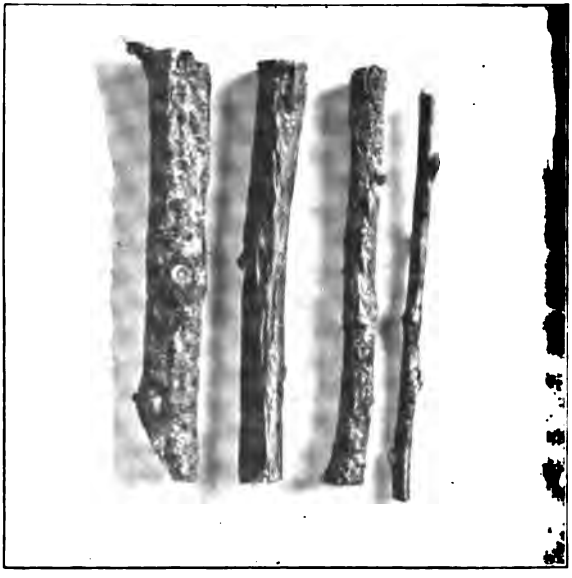

FIG. 1.—SAN JOSÉ SCALE
(Aspidiotus perniciosus) on Peach branches (nat. size).

FIG. 2.—OYSTER-SHELL BARK LOUSE OR SCALE
(Aspidiotus ostreæformis) on Plum branch (nat. size). The small branch to the right is from a healthy tree, and is free from scale.

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R. Newstead, photo. *Adlard & Son, Imp.*

PLATE C.

EXPLANATION OF PLATE C.

Fig. 1. PSEUDOCOCCUS ULICIS. (Pages 32 and 41.)

Common in a few localities, but very local. It is apparently immune from birds, but much subject to the attacks of small Hymenopterous parasites *when the ovisacs are massed* together as shown in the three large branches of the food-plant. When isolated I have found them almost immune. Note the resemblance of the latter to bird-droppings.

Fig. 2. APTEROCOCCUS FRAXINI. (Page 41.)

This species somewhat resembles *Cryptococcus fagi* (see Pl. A, fig. 2), but the ovisacs of the females are smaller and never massed together as in the latter. It is given here as a second example of a British Coccid apparently immune from the attacks of both birds and insects.

FIG. 1.—*Pseudococcus ulicis* on Gorse (nat. size).

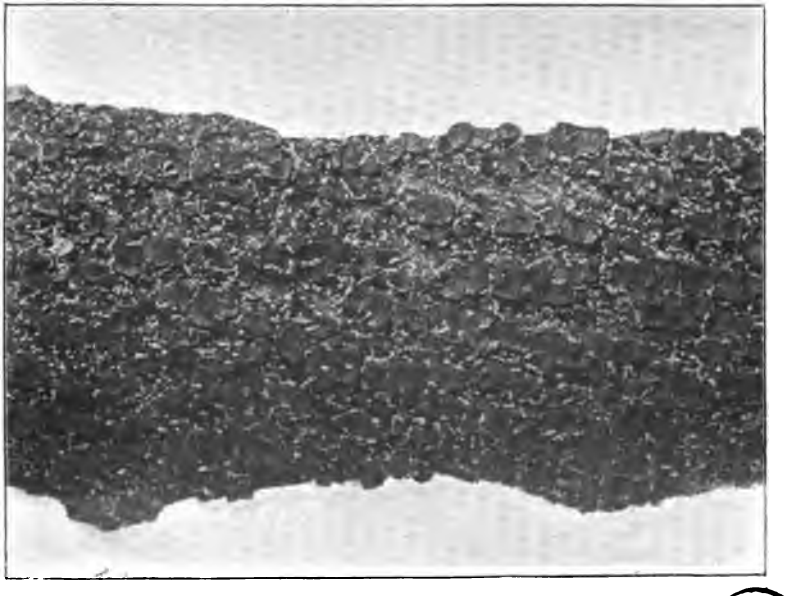

FIG 2.—FELTED ASH COCCUS
(Apterococcus fraxini) on Ash bark (nat. size).

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PLATE D.

EXPLANATION OF PLATE D.

Fig. 1. CHIONASPIS SALICIS. (Pages 37 and 38.)

At A are shown the female puparia on ash branch, as they appear in early autumn. In winter they harmonise exactly with the colour of the bark, and are much less conspicuous. The lower branch (B) is almost covered with the empty puparia of the males; beneath them the females are as numerous as on the branch above them. This species is freely eaten by birds.

Fig. 2. ASTERODIASPIS QUERCICOLA. (Pages 34—39.)

Given as an illustration of one of the British Coccids which is freely eaten by birds. On the first branch (to the left) four of the insects are seen inhabiting the gall-pits or swellings produced by the insects. On the fourth branch are three gall-pits which have been robbed of the insects by titmice. Other empty gall-pits are also seen on the other branches.

A

B

FIG. 1.—ASH AND WILLOW SCALE

(Chionaspis salicis) on branches of Ash (nat. size).

FIG. 2.—PIT-MAKING OAK COCCID

(Asterodiaspis quercicola) on Oak branches (nat. size).

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R. Newstead, photo. *Adlard & Son, Imp.*

PLATE E.

EXPLANATION OF PLATE E.

Fig. 1. LECANIUM GENEVENSE. (Page 39.)

Much subject to the attacks of hymenopterous parasites. Has been found in the stomach of the jackdaw, and sparrows appear also to eat them.

Fig. 2. PULVINARIA RIBESIÆ. (Page 40.)

This species is not known to be attacked by birds in this country when in this state, but the young and inconspicuous brown females are.

FIG. 1.—HAWTHORN AND APPLE SCALE *(Lecanium genevense)* on branch of Hawthorn partly destroyed by the insects (nat. size).

FIG. 2.—COTTONY CUSHION SCALE OF THE CURRANT *(Pulvinaria ribesiæ)* on branch of Currant (nat. size).

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PLATE I.

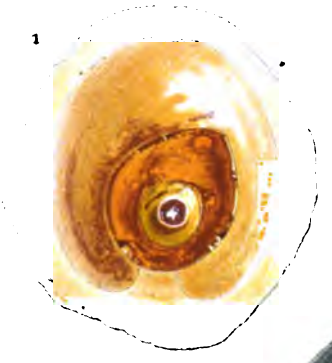
EXPLANATION OF PLATE I.

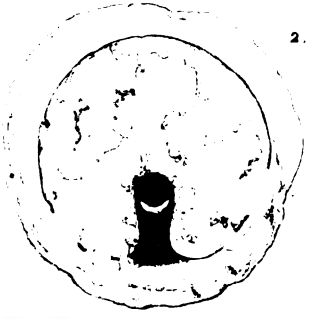
ASPIDIOTUS AURANTII. (Page 88.)

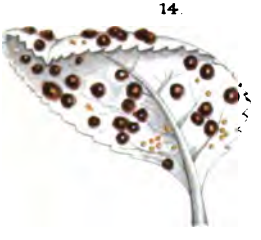
Fig. 1. Puparium of adult female, dorsal view. × 25.
2. Puparium of the adult female, ventral view, with the ventral scale partly removed, disclosing the female within. × 25.
3. Adult female after treatment with potash. × 50.
4. Parasitised immature female removed from the puparium. × 25.
5. Puparium of the male. × 25.
6. Insects, natural size, *in situ* on piece of orange rind.

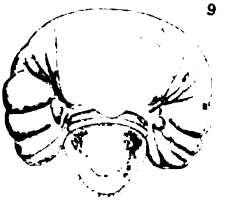
ASPIDIOTUS FICUS. (Page 104.)

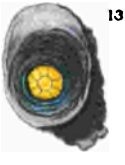
Fig. 7. Puparium of adult female, dorsal view, with puparium of very young female superimposed at side. × 25.
8. Puparium of young female. × 25.
9. Adult female at period of parturition. × 25.
10. Adult female after treatment with potash. × 50.
11. Thoracic spine of female. × 600.
12. Puparium of the male (dorsal). × 25.
13. Puparium of the male (ventral). × 25.
14. Insects, natural size, *in situ* on leaf of *Ficus*.

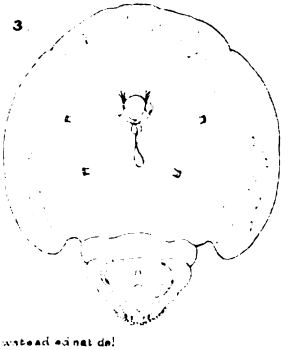


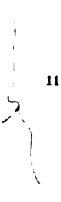












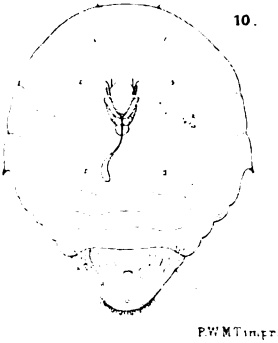


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PLATE II.

EXPLANATION OF PLATE II.

ASPIDIOTUS AURANTII. (Page 88.)

Fig. 1. Pygidium of adult female. × 250.

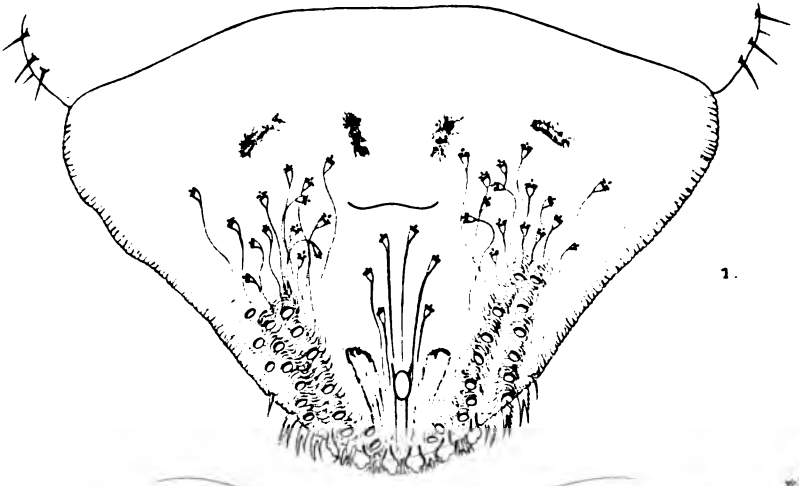
ASPIDIOTUS FICUS. (Page 104.)

Fig. 2. Pygidium of adult female. × 250.

ASPIDIOTUS DICTYOSPERMI, var. ARECÆ. (Page 107.)

Fig. 3. Pygidium of adult female. × 250.

Pl. II.



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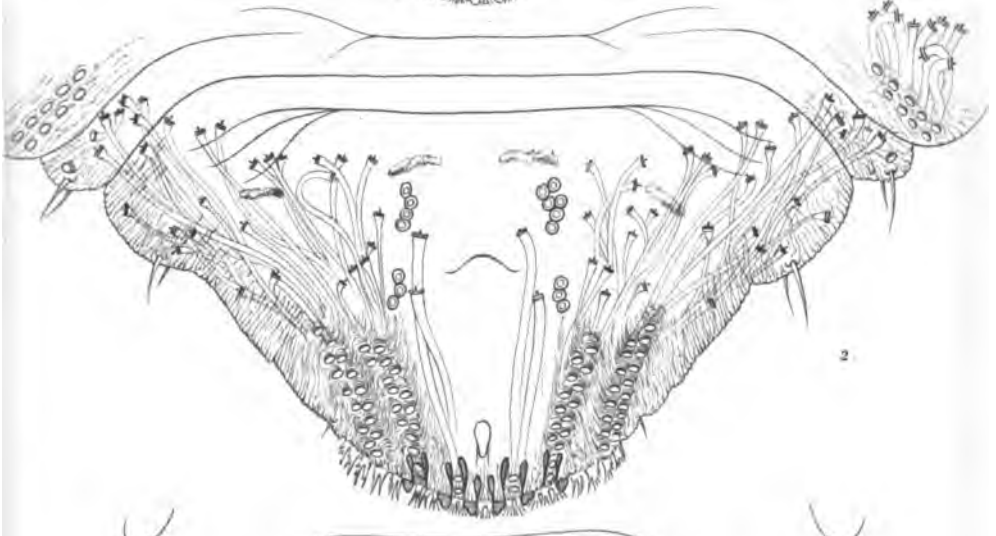

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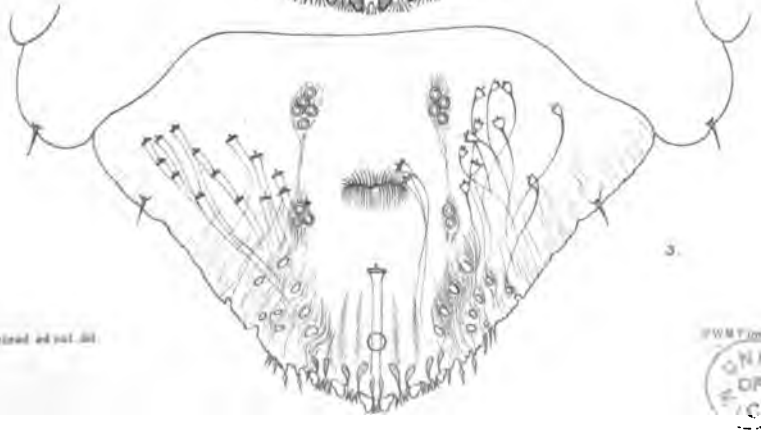

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PLATE III.

EXPLANATION OF PLATE III.

ASPIDIOTUS BROMELIÆ. (Page 86.)

Fig. 1. Puparium of adult female, dorsal view, showing naked black exuviæ. × 25.
2. Scale of adult female, ventral view, with greater portion of ventral scale broken away, showing the adult female at *large anterior* extremity, and the eggs at narrow posterior extremity. × 25.
3. Puparium of the second-stage female. × 25.
4. Puparium of the male. × 25.
5. Insects, natural size, *in situ* on portion of pine-apple.

ASPIDIOTUS CAMELLIÆ. (Page 91.)

Fig. 6. Puparium of adult female. × 25.
7. Adult female at period of gestation. × 30.
8. Insects, natural size, *in situ* on leaf of camellia.

ASPIDIOTUS PERSONATUS. (Page 83.)

Fig. 9. Puparia of adult female (profile). × 25.
10. Puparium of adult female, ventral view, with portion of yellow ventral scale broken away, revealing the female within. × 25.
11. Ventral scale attached to leaf, surrounded by a zone of discoloration of the leaf tissues. × 25.
12. Adult female after treatment with potash. × 50.
13. Insects, natural size, *in situ* on leaf of *Tillandsia*.

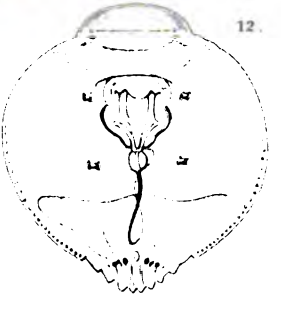

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PLATE IV.

EXPLANATION OF PLATE IV.

ASPIDIOTUS PERSONATUS. (Page 83.)

Fig. 1. Pygidium of adult female. × 250.

ASPIDIOTUS BROMELIÆ. (Page 86.)

Fig. 2. Pygidium of adult female. × 250.

ASPIDIOTUS CAMELLIÆ. (Page 91.)

Fig. 3. Pygidium of adult female. × 250.

Pl. IV.

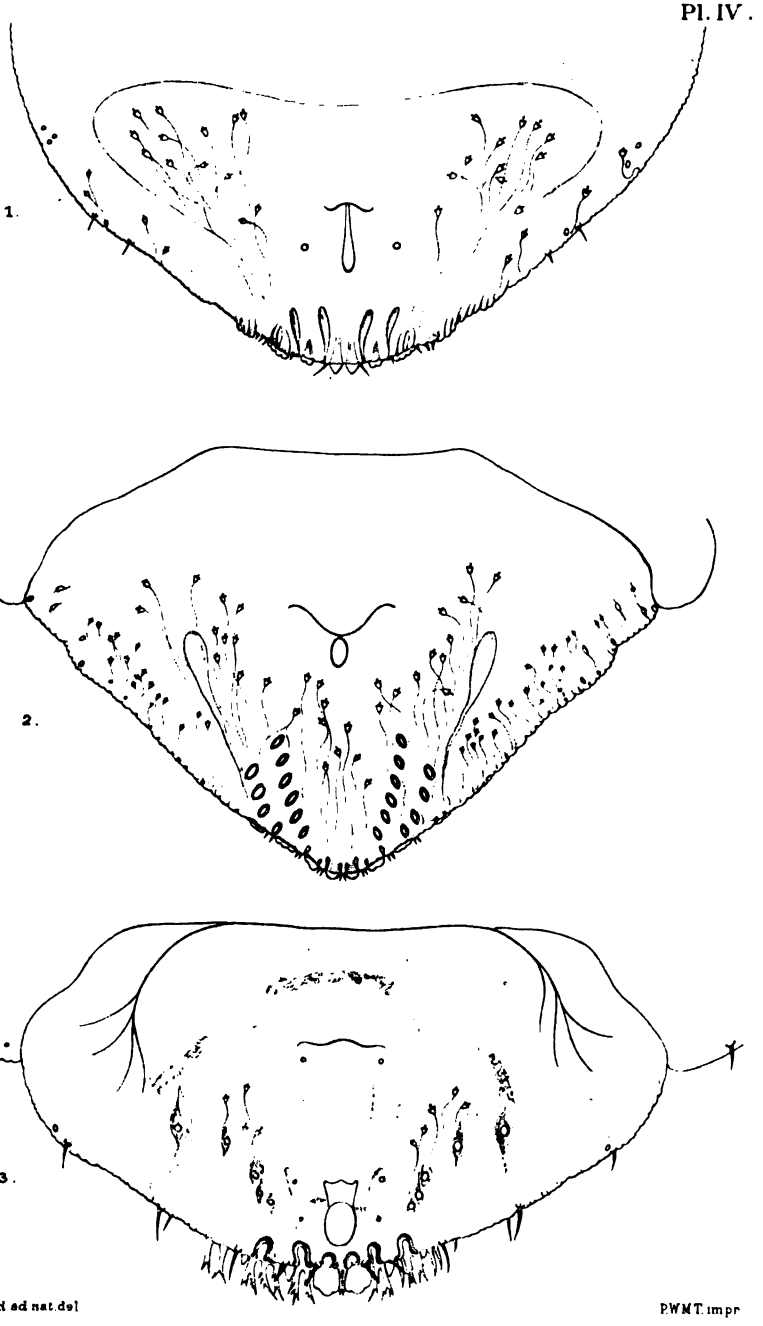

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PLATE V.

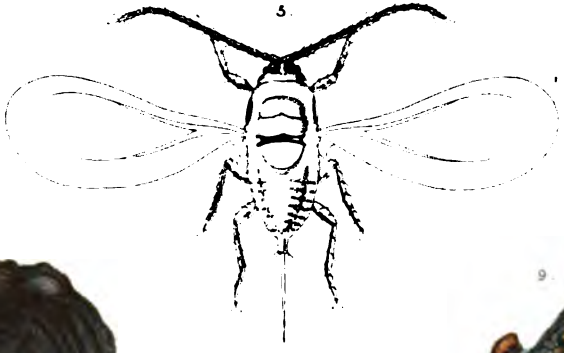
PLATE III.

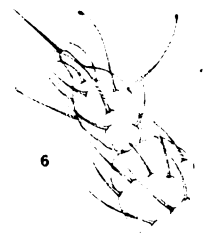
PLATE VI.

EXPLANATION OF PLATE VI.

ASPIDIOTUS ZONATUS. (Pages 36, 37, and 94.)

Fig. 1. Puparium of adult female covered with sooty deposit; larval exuviæ naked. × 25.
2. Puparium of immature female, as found behind the bud scales in autumn. × 25.
3. Female at period of gestation. × 35.
4. Puparium of the male on portion of oak leaf. × 25.
5. Male. × 50.
6. Apical joint of male antennæ. × 600.
7. Tarsus and claw of male. × 600.
8. Male puparia, natural size, *in situ* on underside of oak leaf.
9. Female puparia, natural size, *in situ* on oak branch. The white concentric rings show where the scales have been removed, and the yellow spots the centre (larval exuviæ) of the puparia of the adult female.





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EXPLANATION OF PLATE IV.

ASPIDIOTUS PERSONATUS. (Page 83.)

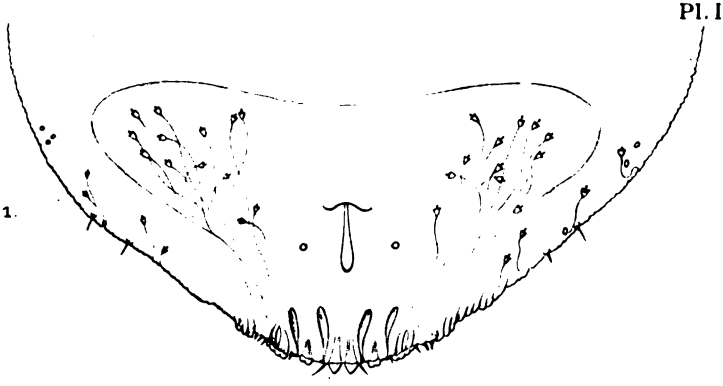
Fig. 1. Pygidium of adult female. × 250.

ASPIDIOTUS BROMELIÆ. (Page 86.)

Fig. 2. Pygidium of adult female. × 250.

ASPIDIOTUS CAMELLIÆ. (Page 91.)

Fig. 3. Pygidium of adult female. × 250.



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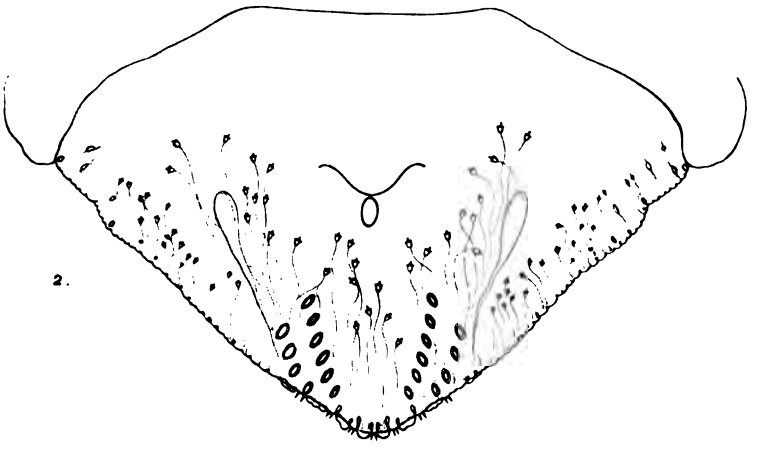

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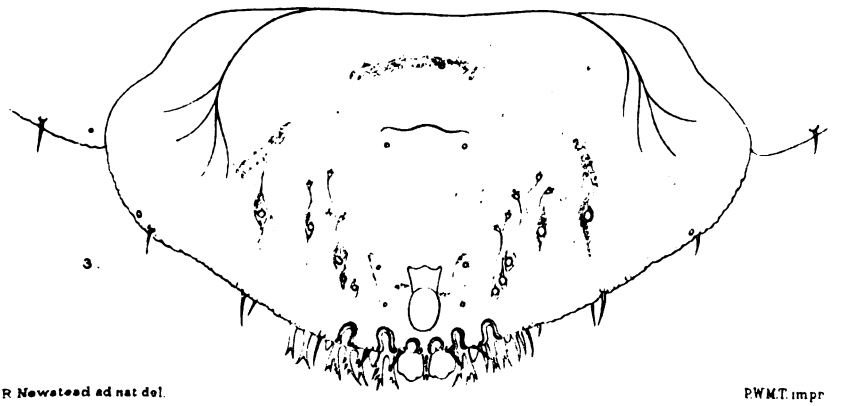

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PLATE V.

PLATE VIII.

EXPLANATION OF PLATE VIII.

ASPIDIOTUS HEDERÆ. (Page 120.)

Fig. 1. Puparium of adult female, dark form. × 25.
2. Puparium of early adult female. × 25.
3. Female at period of gestation. × 35.
4. Parasitised female, showing pupa of parasite within. × 25.
5. Puparium of the male. × 25.
6. Insects, natural size, *in situ* on portion of lemon rind.
7. Insects, natural size, *in situ* on leaf of *Nerium oleander*.

ASPIDIOTUS BRITANNICUS. (Page 117.)

Fig. 8. Puparium of adult female. × 25.
9. Puparia of immature female. × 25.
10. Adult female at period of gestation. × 25.
11. Puparium of the male. × 25.
12. Insects, natural size, *in situ* on holly leaf.

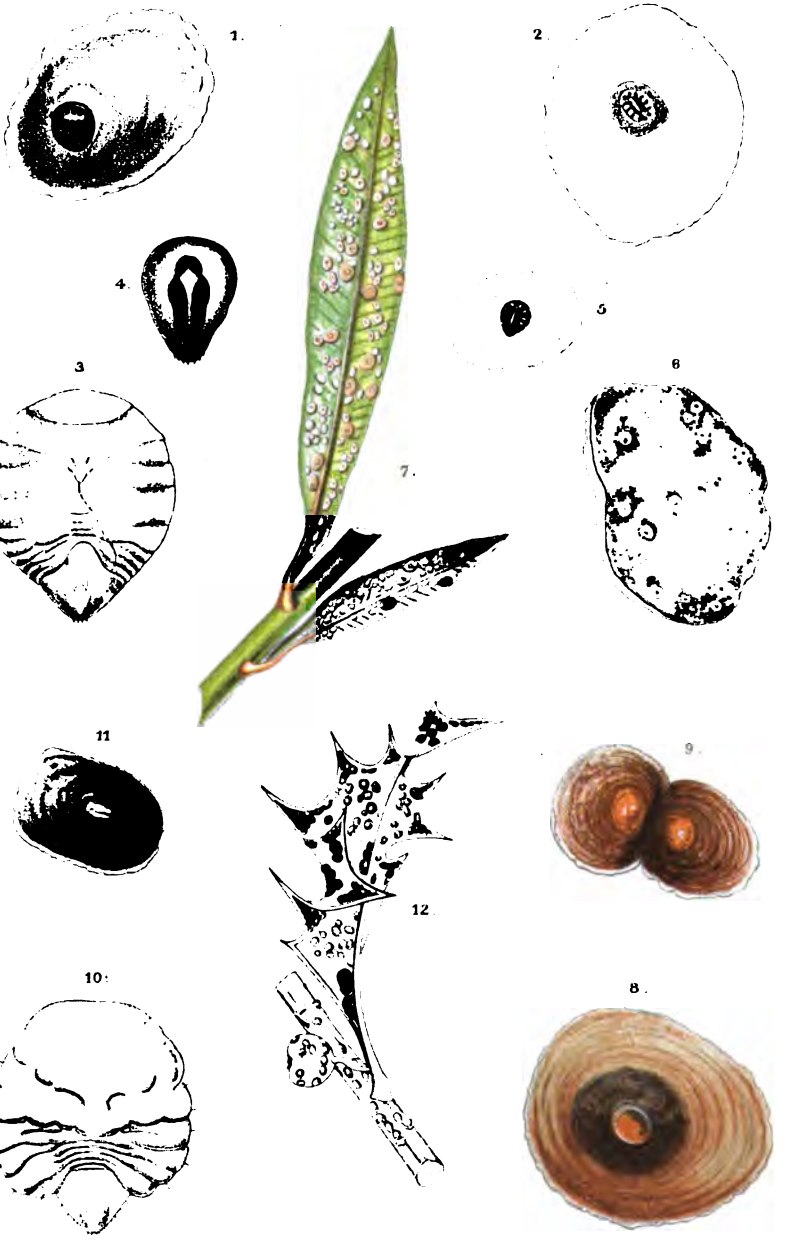

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PLATE IX.

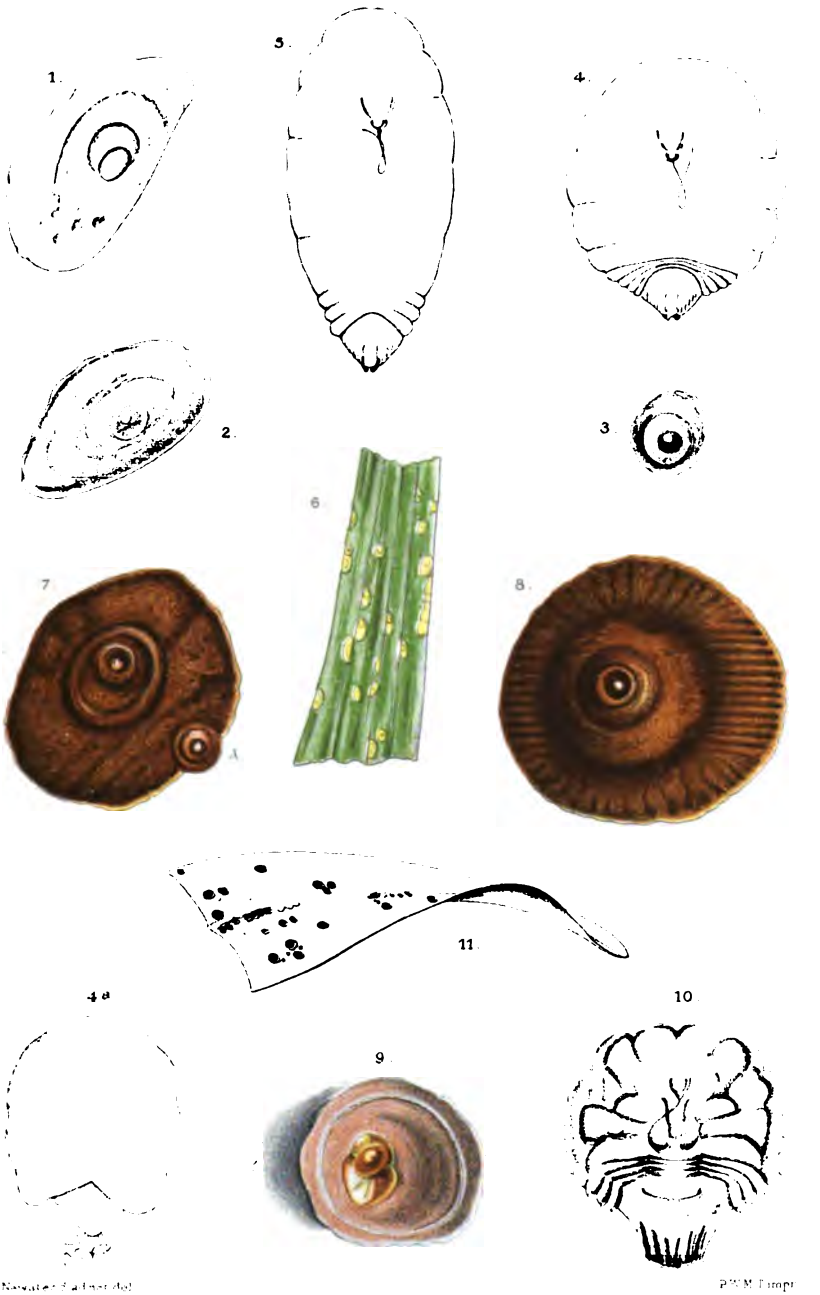
EXPLANATION OF PLATE IX.

ASPIDIOTUS CYANOPHYLLI. (Page 124.)

Fig. 1. Puparium of adult female. × 25.
2. Puparium of adult female, old opaque form. × 25.
3. Puparium of the male. × 25.
4. Adult female, ovate form at period of gestation from palm (ventral). × 40.
4*a*. Adult female after parturition (dorsal). × 40.
5. Adult female, elongate form from *Aralia* at gestation (ventral). × 40.
6. Insects, natural size, *in situ* on portion of palm leaf.

ASPIDIOTUS DICTYOSPERMI, var. ARECÆ. (Page 107.)

Fig. 7. Puparium of adult female with large concentric ring, indicating extent of second exuviæ, and with a young scale superimposed at the margin. × 25.
8. Puparium of adult female without large concentric ring, showing alteration in the structural character of surface caused by epidermal layer of plant tissues. × 25.
9. Puparium of young adult female, ventral aspect, showing form and position of larval and second exuviæ. × 30.
10. Adult female at period of gestation. × 40.
11. Insects, natural size, *in situ* on portion of leaf of *Cœlogyne*.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EXPLANATION OF PLATE IX.

ASPIDIOTUS CYANOPHYLLI. (Page 124.)

Fig. 1. Puparium of adult female. × 25.
2. Puparium of adult female, old opaque form. × 25.
3. Puparium of the male. × 25.
4. Adult female, ovate form at period of gestation from palm (ventral). × 40.
4 *a*. Adult female after parturition (dorsal). × 40.
5. Adult female, elongate form from *Aralia* at gestation (ventral). × 40.
6. Insects, natural size, *in situ* on portion of palm leaf.

ASPIDIOTUS DICTYOSPERMI, var. ARECÆ. (Page 107.)

Fig. 7. Puparium of adult female with large concentric ring, indicating extent of second exuviæ, and with a young scale superimposed at the margin. × 25.
8. Puparium of adult female without large concentric ring, showing alteration in the structural character of surface caused by epidermal layer of plant tissues. × 25.
9. Puparium of young adult female, ventral aspect, showing form and position of larval and second exuviæ. × 30.
10. Adult female at period of gestation. × 40.
11. Insects, natural size, *in situ* on portion of leaf of *Cœlogyne*.

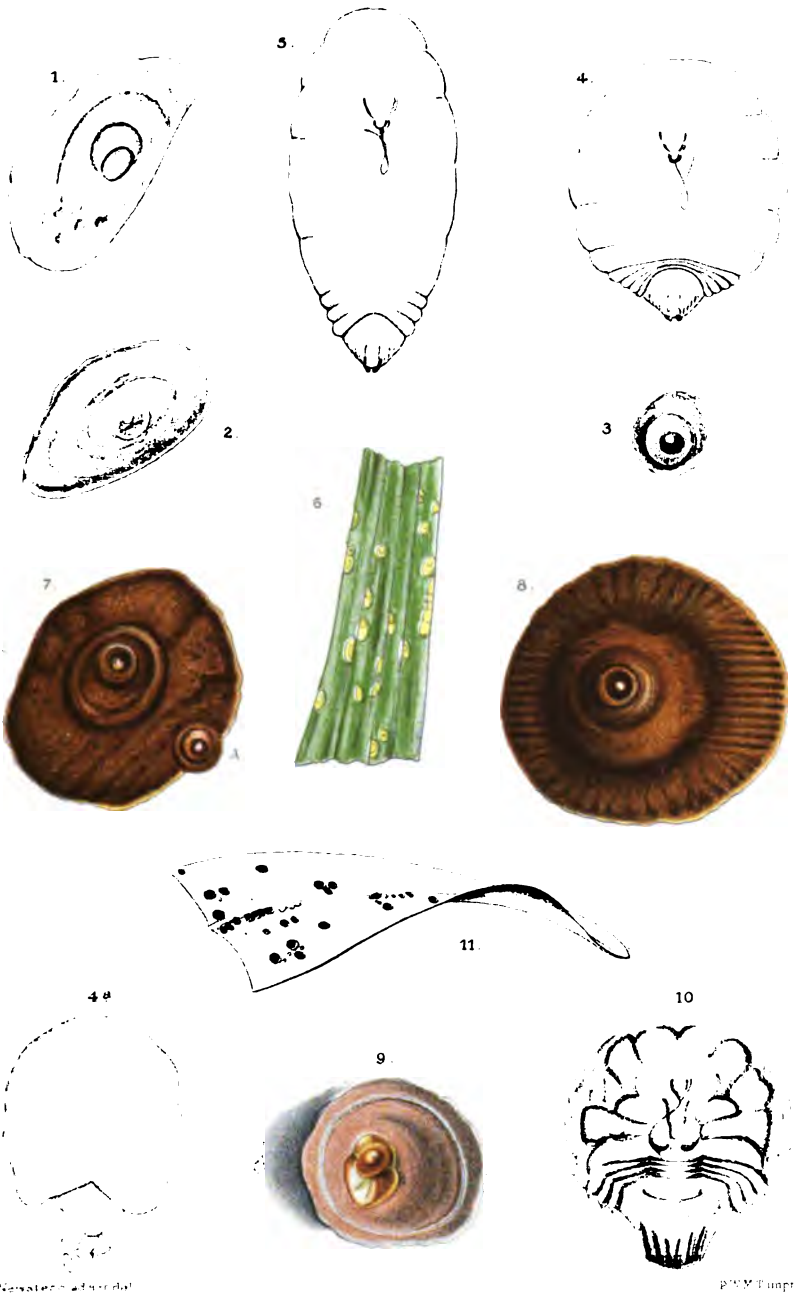
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PLATE X.

EXPLANATION OF PLATE X.

ASPIDIOTUS HEDERÆ. (Page 120.)

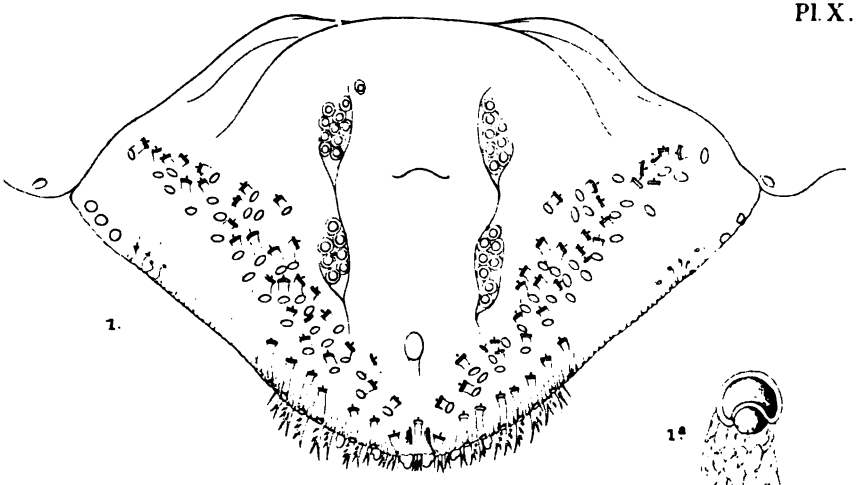
Fig. 1. Pygidium of adult female. × 250.
1 *a*. Spiracle of female. × 600.

ASPIDIOTUS CYANOPHYLLI. (Page 124.)

Fig. 2. Pygidium of adult female. × 250.

ASPIDIOTUS SPINOSUS. (Page 114.)

Fig. 3. Pygidium of adult female. × 250.



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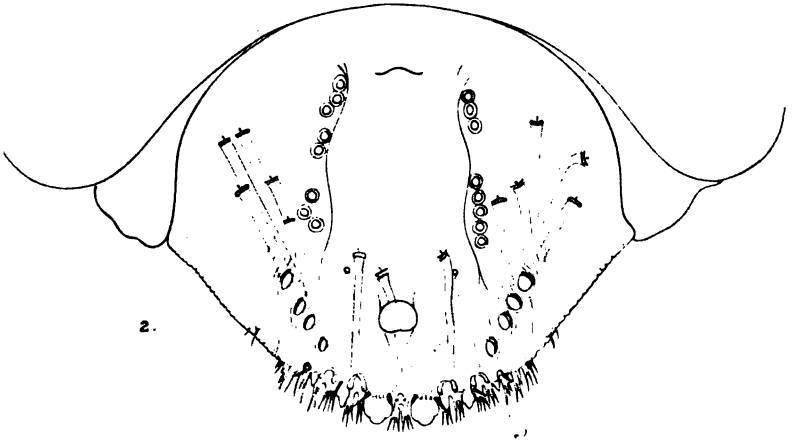

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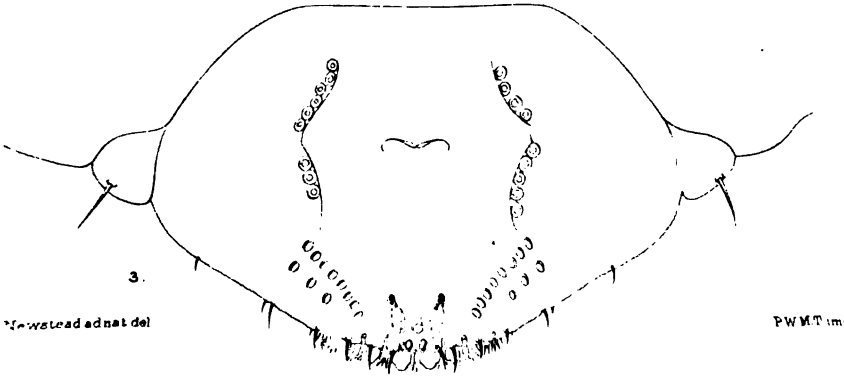

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PLATE XI.

EXPLANATION OF PLATE XI.

ASPIDIOTUS AURANTII. (Page 88.)

Fig. 1. Margin of pygidium of adult female. × 600.

ASPIDIOTUS FICUS. (Page 104.)

Fig. 2. Margin of pygidium of adult female. × 600.

ASPIDIOTUS CAMELLIÆ. (Page 91.)

Fig. 3. Margin of pygidium of adult female. × 600.

ASPIDIOTUS SPINOSUS. (Page 114.)

Fig. 4. Margin of pygidium of adult female. × 600.

ASPIDIOTUS PERSONATUS. (Page 83.)

Fig. 5. Margin of pygidium of adult female. × 600.

ASPIDIOTUS BROMELIÆ. (Page 86.)

Fig. 6. Margin of pygidium of adult female. × 600.

ASPIDIOTUS PERSEÆ. (Page 112.)

Fig. 7. Margin of pygidium of adult female. (After Comstock.)

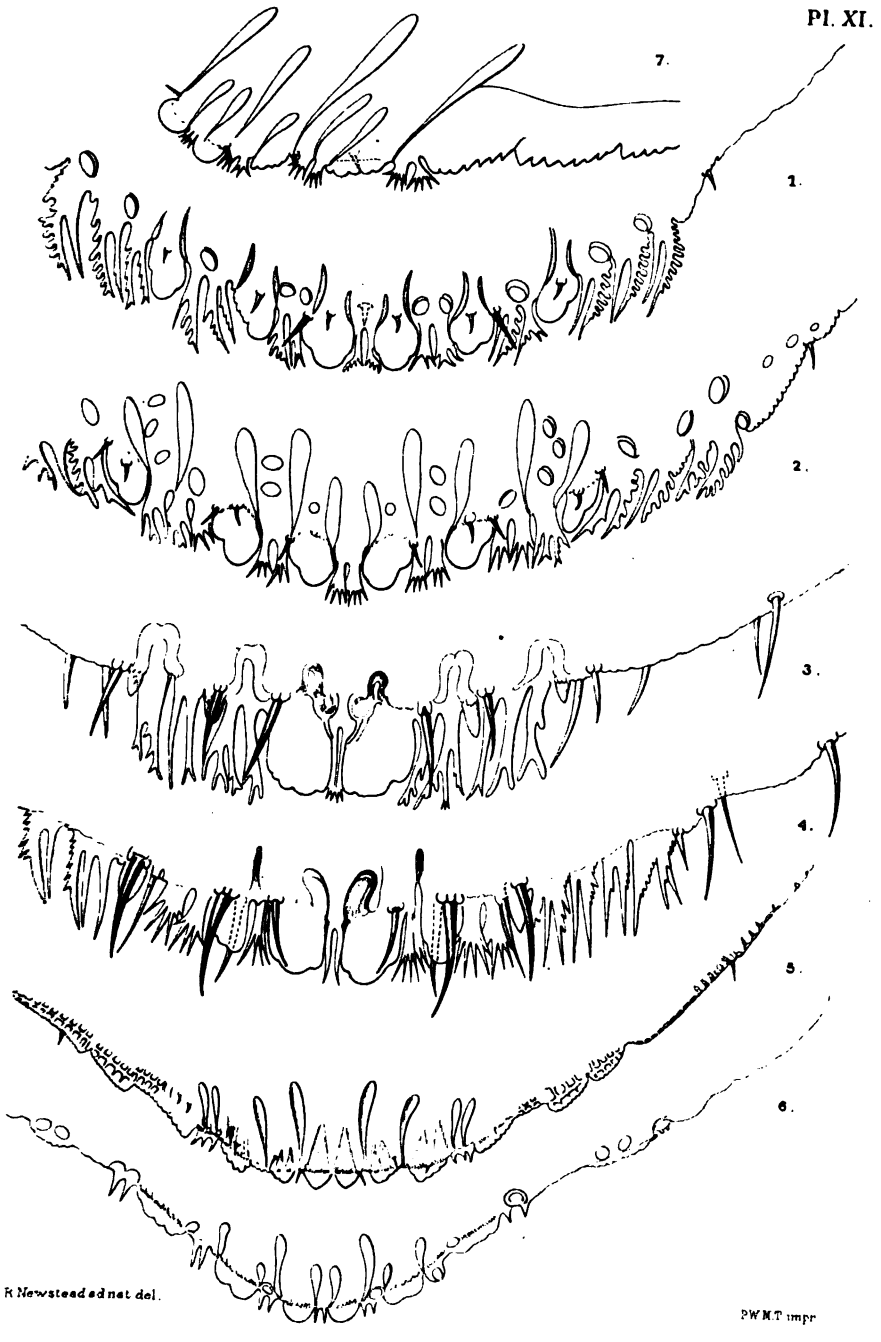

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PLATE XII.

EXPLANATION OF PLATE XII.

ASPIDIOTUS OSTREÆFORMIS. (Page 99.)

Fig. 1. Margin of pygidium of adult female. × 600.

ASPIDIOTUS ZONATUS. (Page 94.)

Fig. 2. Margin of pygidium of adult female. × 600.

ASPIDIOTUS HEDERÆ. (Page 120.)

Fig. 3. Margin of pygidium of adult female. × 600.

ASPIDIOTUS BRITANNICUS. (Page 117.)

Fig. 4. Margin of pygidium of adult female. × 600.

ASPIDIOTUS CYANOPHYLLI. (Page 124.)

Fig. 5. Margin of pygidium of adult female. × 600.

ASPIDIOTUS DICTYOSPERMI, var. ARECÆ. (Page 107.)

Fig. 6. Margin of pygidium of adult female. × 600.

Pl. XII.

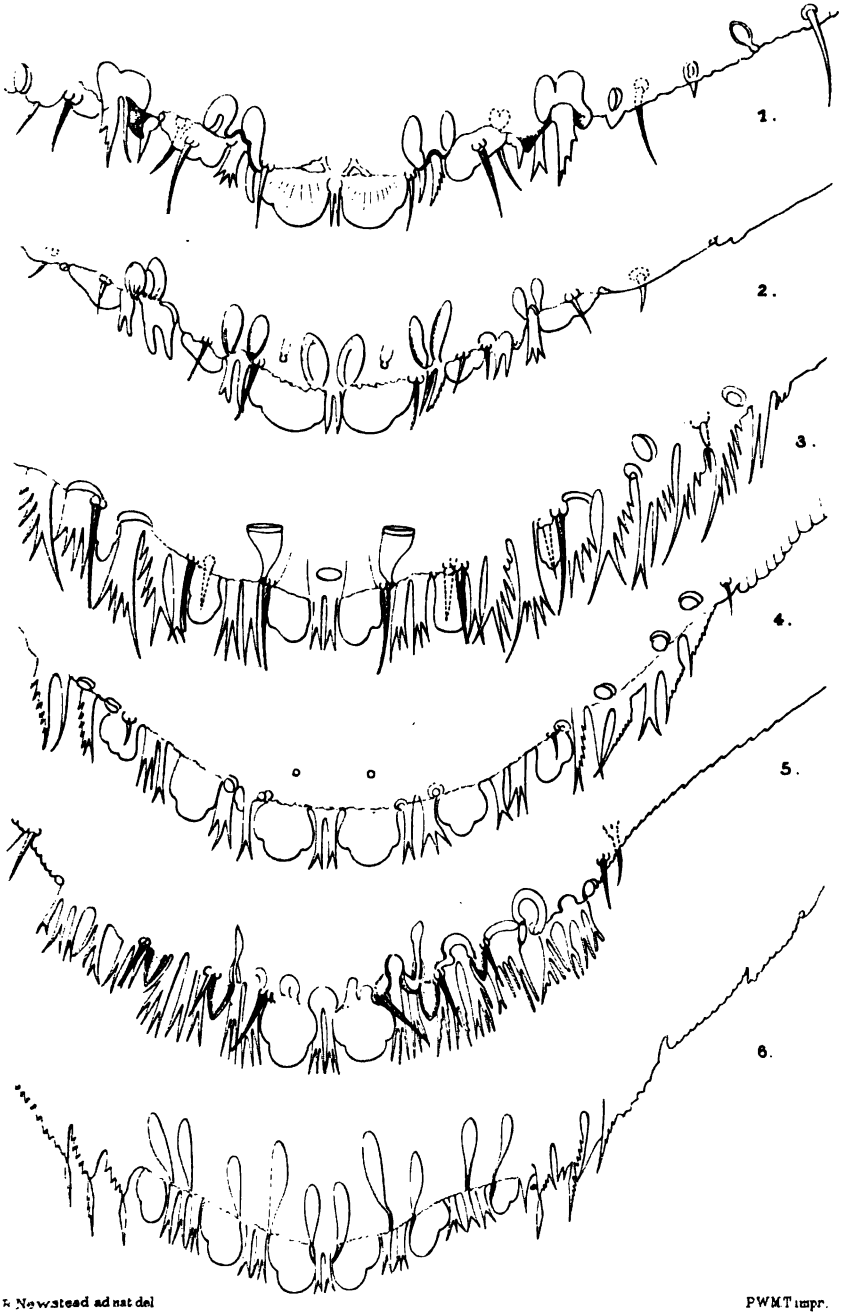

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PLATE XIII.

EXPLANATION OF PLATE XIII.

DIASPIS BROMELIÆ. (Page 156.)

Fig. 1. Insects, natural size, *in situ* on portion of pine-apple (perianth).
2. Puparium of adult female. × 20.
3. Adult female at period of gestation. × 35.
4. Adult female after parturition. × 35.
5. Puparium of male. × 20.
6. Male. × 35.
7. Ova.

DIASPIS BOISDUVALII. (Page 153.)

Fig. 8. Insects, natural size, *in situ* on portion of palm leaf.
9. Adult female after treatment with potash. × 45.
10. Thoracic tubercle of adult female. × 500.

DIASPIS CALYPTROIDES. (Page 159.)

Fig. 11. Insects, natural size, *in situ* on portion of cactus.
12. Adult female after treatment with potash. × 45.

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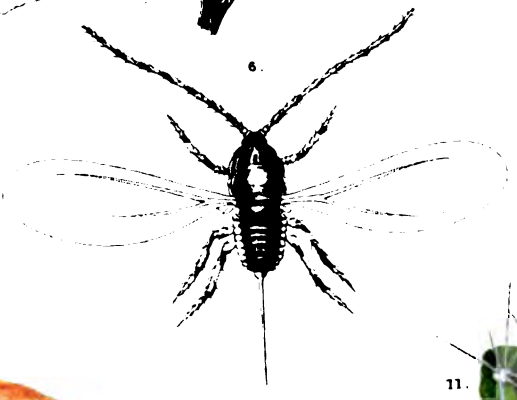
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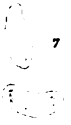
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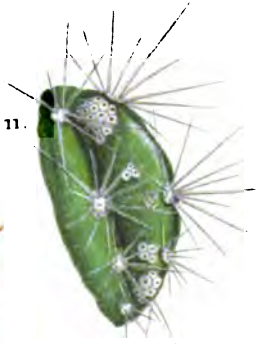
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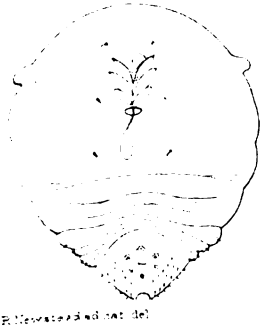
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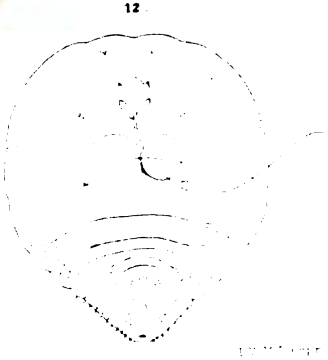
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PLATE XIV.

EXPLANATION OF PLATE XIV.

AULACASPIS ROSÆ. (Page 168.)

Fig. 1. Insects, natural size, *in situ* on branch of wild rose.
2. Puparia of adult female, dorsal view. × 15.
3. Puparia of adult female, ventral view, disclosing female and eggs. × 20.
4. Adult female at gestation. × 35.
5. Puparium of second-stage female at period of fecundation. × 20.
6. Puparium of the male. × 20.
7. Male. × 30.
8. Apical joint of antenna of male. × 500.
8 *a*. Another view of the same. × 600.
9. Tarsus and claw of male. × 500.
10. Larva escaping from egg. × 60.
11. Fully developed larva. × 60.
12. Larva showing change of colour immediately prior to first moult. × 50.
13. The same just after the moult, showing commencement of secreted portion of the male puparium. × 50.

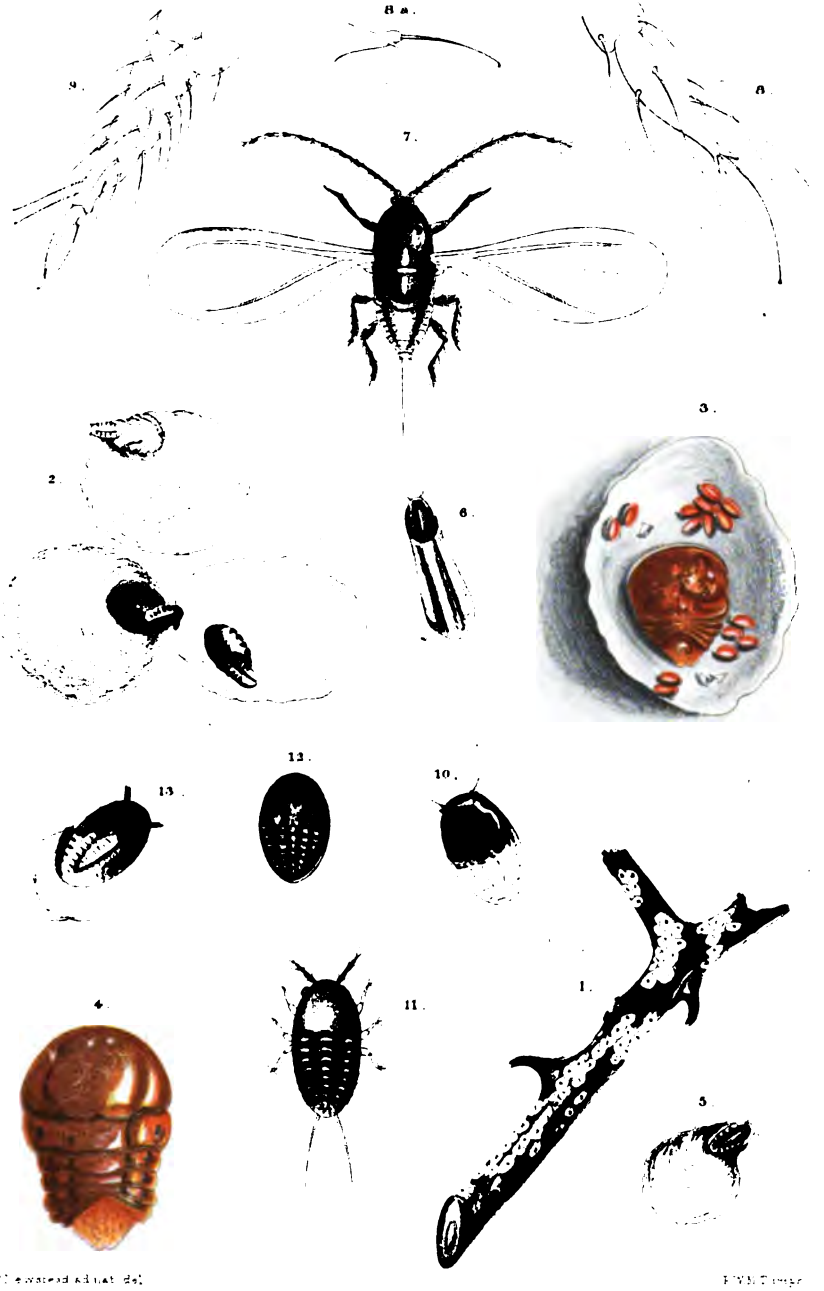
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PLATE XV.

EXPLANATION OF PLATE XV.

POLIASPIS CYCADIS. (Page 177.)

Fig. 1. Insects, natural size, *in situ* on portion of leaf of Cycas.
2. Puparium of adult female. × 15.
3. Puparium of immature female with plant filaments attached. × 15.
4. Puparium of male. × 20.
5. Adult female after treatment with potash. × 45.
6. Rudimentary antennæ of adult female. × 600.
7. Posterior spiracles with glands of adult female. × 600.
8. Anterior spiracles of adult female. × 600.

PINNASPIS BUXI. (Page 207.)

Fig. 9. Insects, natural size.
13. The same, showing stains on palm leaf caused by the insects.
10. Puparium of adult female. × 35.
11. Adult female (dorsal). × 45.
12. Doubtful puparium of male. × 35.

DIASPIS ZAMIÆ. (Page 165.)

Fig. 14. Insects, natural size, *in situ* on leaf of Cycas.
15. Puparium of adult and immature female. × 15.
16. Adult female after treatment with potash. × 45.
17. Spiracle of adult female with glands. × 600.

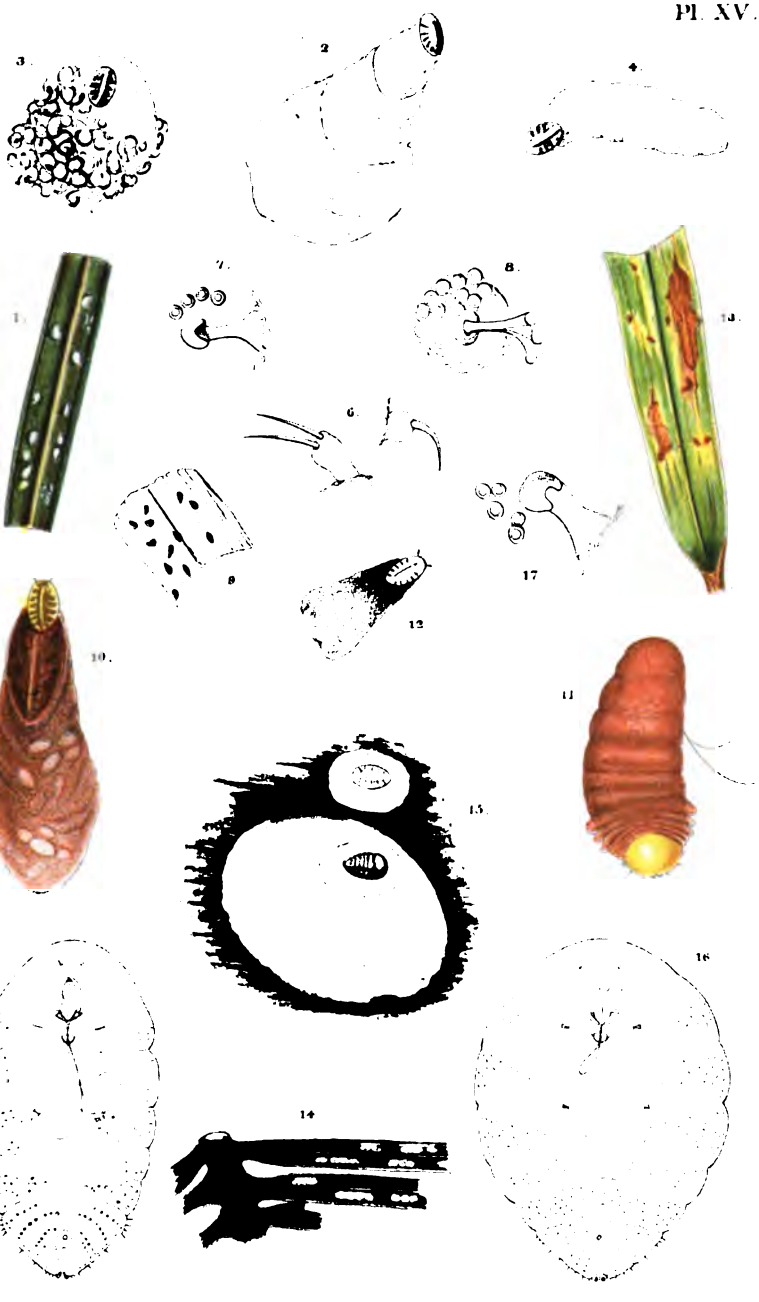
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PLATE XVI.

EXPLANATION OF PLATE XVI.

DIASPIS BROMELIÆ. (Page 156.)

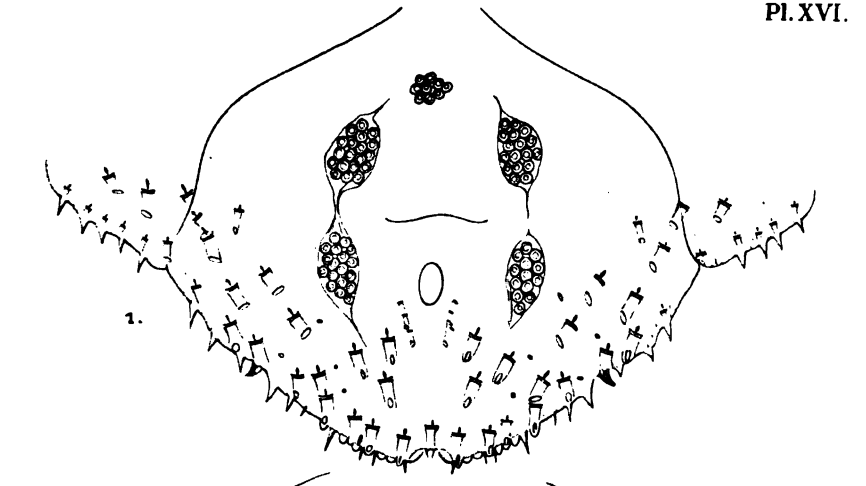
Fig. 1. Pygidium of adult female. × 250.

DIASPIS BOISDUVALII. (Page 153.)

Fig. 2. Pygidium of adult female. × 250.

DIASPIS CALYPTROIDES. (Page 159.)

Fig. 3. Pygidium of adult female. × 250.



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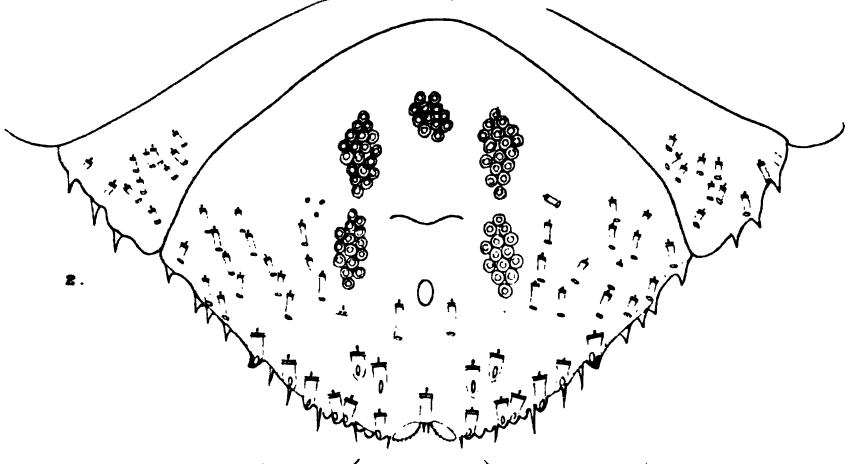

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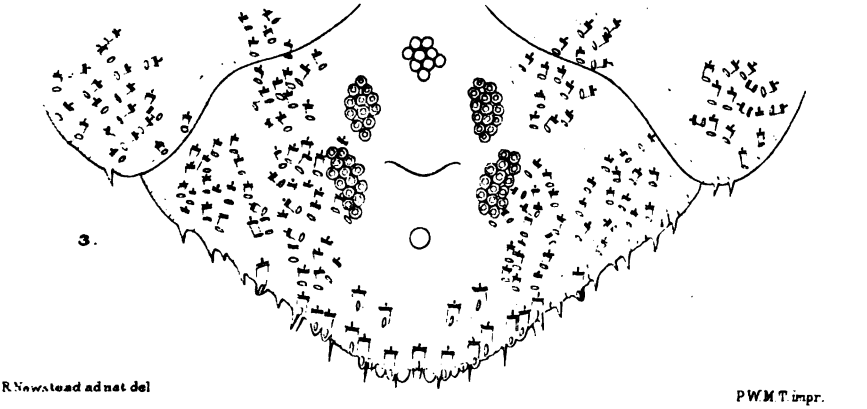

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PLATE XVII.

PLATE XV.

PLATE XVIII.

EXPLANATION OF PLATE XVIII.

DIASPIS BROMELIÆ. (Page 156.)

Fig. 1. Margin of pygidium of adult female. × 600.

DIASPIS BOISDUVALII. (Page 153.)

Fig. 2. Margin of pygidium of adult female. × 600.
8. Antenna of larva. × 600.

DIASPIS CALYPTROIDES. (Page 159.)

Fig. 3. Margin of pygidium of adult female. × 600.

DIASPIS ZAMLÆ. (Page 165.)

Fig. 4. Margin of pygidium of adult female. × 600.

AULACASPIS ROSÆ. (Page 168.)

Fig. 5. Margin of pygidium of adult female. × 600.
7. Antenna of larva. × 600.

POLIASPIS CYCADIS. (Page 177.)

Fig. 6. Margin of pygidium of adult female. × 600.

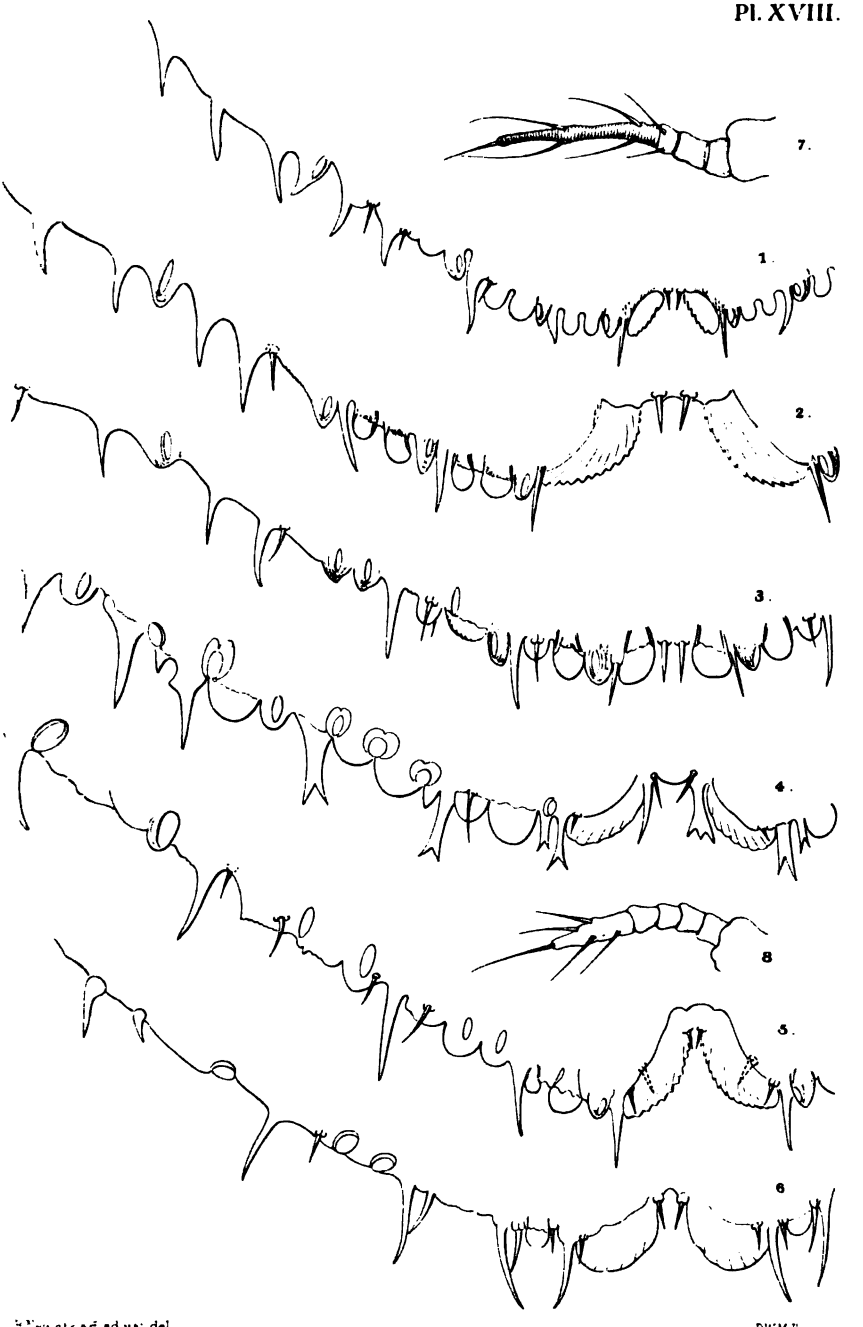

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PLATE XIX.

EXPLANATION OF PLATE XIX.

CHIONASPIS SALICIS. (Page 180.)

Fig. 1. Insects, natural size, *in situ* on willow branch.
2. Puparium of adult female. × 15.
2 *a*. Puparia with epidermal layer of bark on surface. × 15.
3. Puparium of female at period of fecundation. × 40.
3 *a*. The same, in profile, showing apterous male in act of copulation. × 25.
4. Adult female at gestation. × 45.
5. Female at period of fecundation. × 70.
6. Puparium of male, showing perfect insect casting off moulted pupal skin. × 35.
7. Empty puparium of male. × 10.
8. Apterous male. × 35.
9. Winged male. × 35.

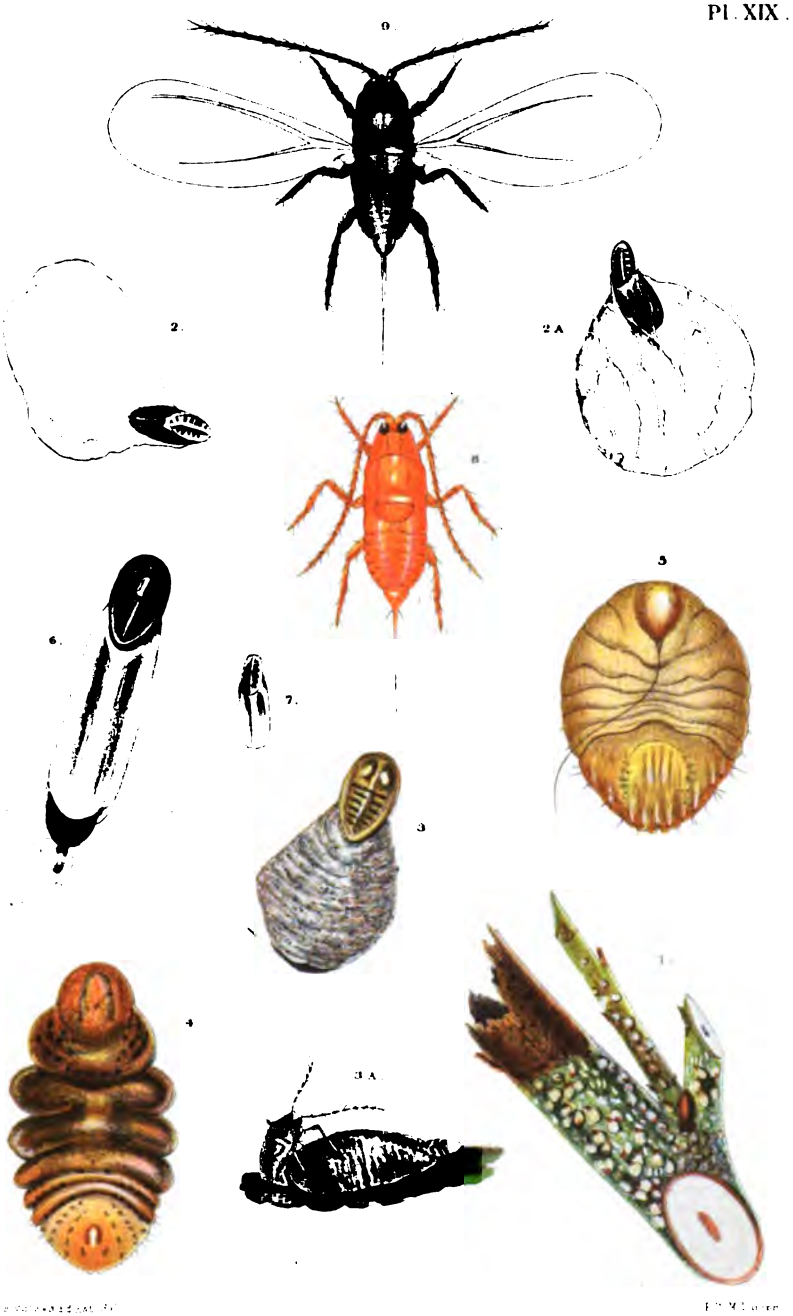

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PLATE XX.

EXPLANATION OF PLATE XX.

CHIONASPIS ASPIDISTRÆ. (Page 187.)

Fig. 1. Female insects, natural size, *in situ* on fern stem (*Asplenium*).
2. Male insects, natural size, on portion of fern leaf (*Asplenium*).
3 and 3 A. Adult female puparia. × 25.
3 B. Puparium of second-stage female. × 25.
4. Adult female at gestation (dorsal). × 45.
5. Parasitised female (ventral). × 45.
6. Puparium of male (dorsal). × 25.
7. The same (ventral), disclosing the second-stage male. × 25.
8, 9. Pupa (dorsal and profile). × 30.
10. Male. × 35.

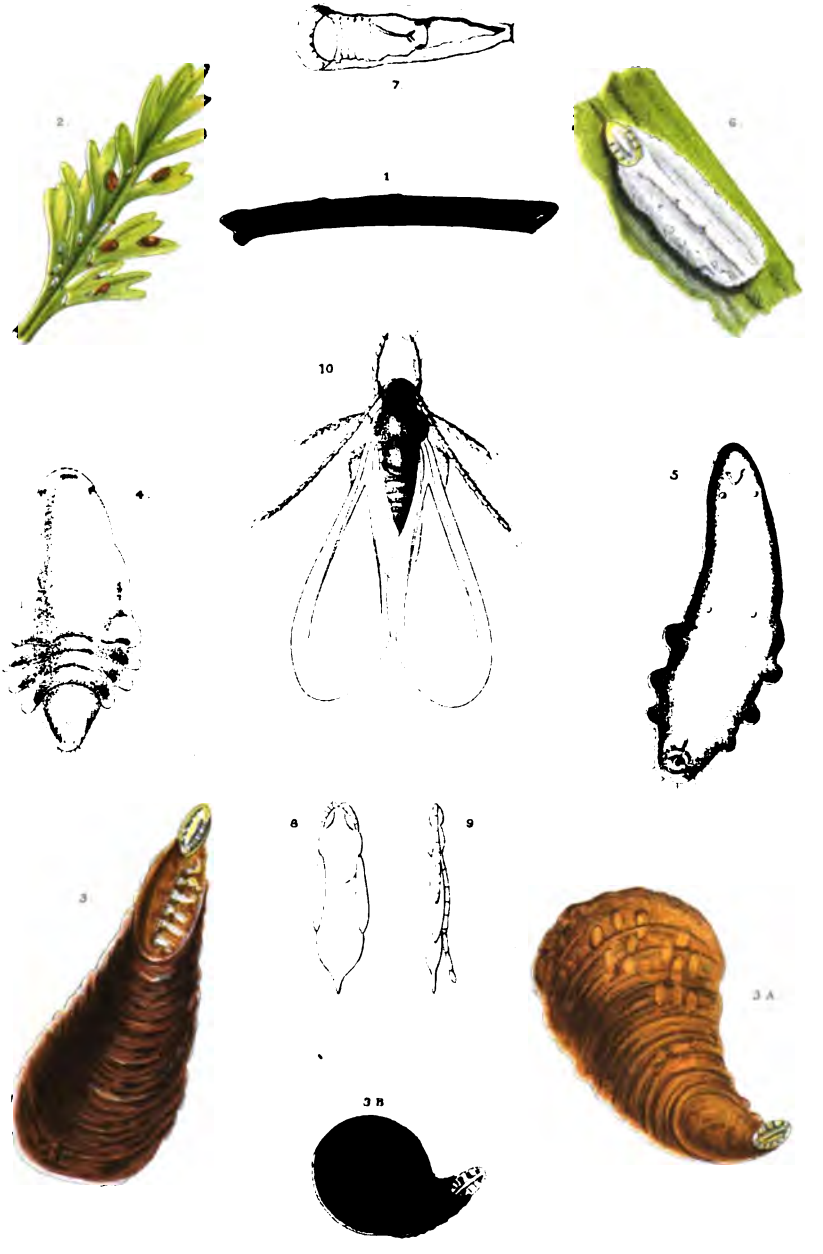

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PLATE XXI.

EXPLANATION OF PLATE XXI.

CHIONASPIS BICLAVIS. (Page 190.)

Fig. 1. *Insects, natural size, *in situ* on branch of tea-plant.
2. *Portion of branch magnified three diameters, showing parasitised, semi-detached, and perfect puparia—marked ♀.
3. †Puparium of adult female (detached) covered with epidermal layer of bark. × 15.
4. †Puparium of adult female with the bark removed (dorsal). × 15.
5. †Puparium of adult female (ventral). × 15.
6. †Adult female after treatment with potash. × 45.
7. †Rudimentary antenna of adult female. × 600.
8. †Tubular spinneret of adult female. × 600.

CHIONASPIS ASPIDISTRÆ. (Page 187.)

Fig. 9. Adult female, parasitised, showing hymenopterous parasite within. × 45.
10. Adult female (normal). × 45.

(Both examples after treatment with potash.)

CHIONASPIS SALICIS. (Page 180.)

Fig. 11. Adult female after treatment with potash. × 45.
12. Antenna of adult female. × 500.
13. Tubular spinneret of adult female. × 600.

* From Cingalese specimens, ex coll. Green.
† From British specimens, ex coll. Douglas.

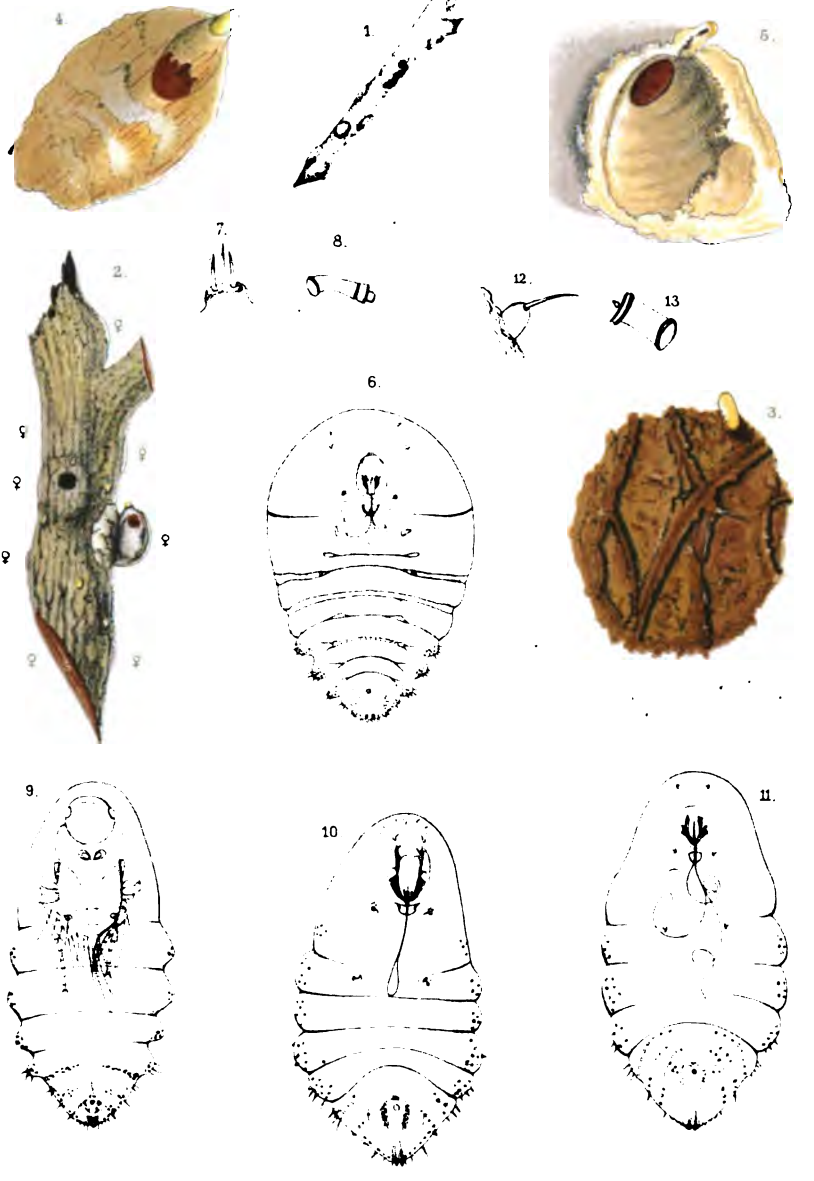

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PLATE XXII.

PLATE XX.

PLATE XXIII.

EXPLANATION OF PLATE XXIII.

CHIONASPIS BICLAVIS. (Page 190.)

Fig. 1. Pygidium of adult female. × 250.

PINNASPIS BUXI. (Page 207.)

Fig. 2. Margin of pygidium of adult female. × 600.
3. Pygidium of adult female. × 250.

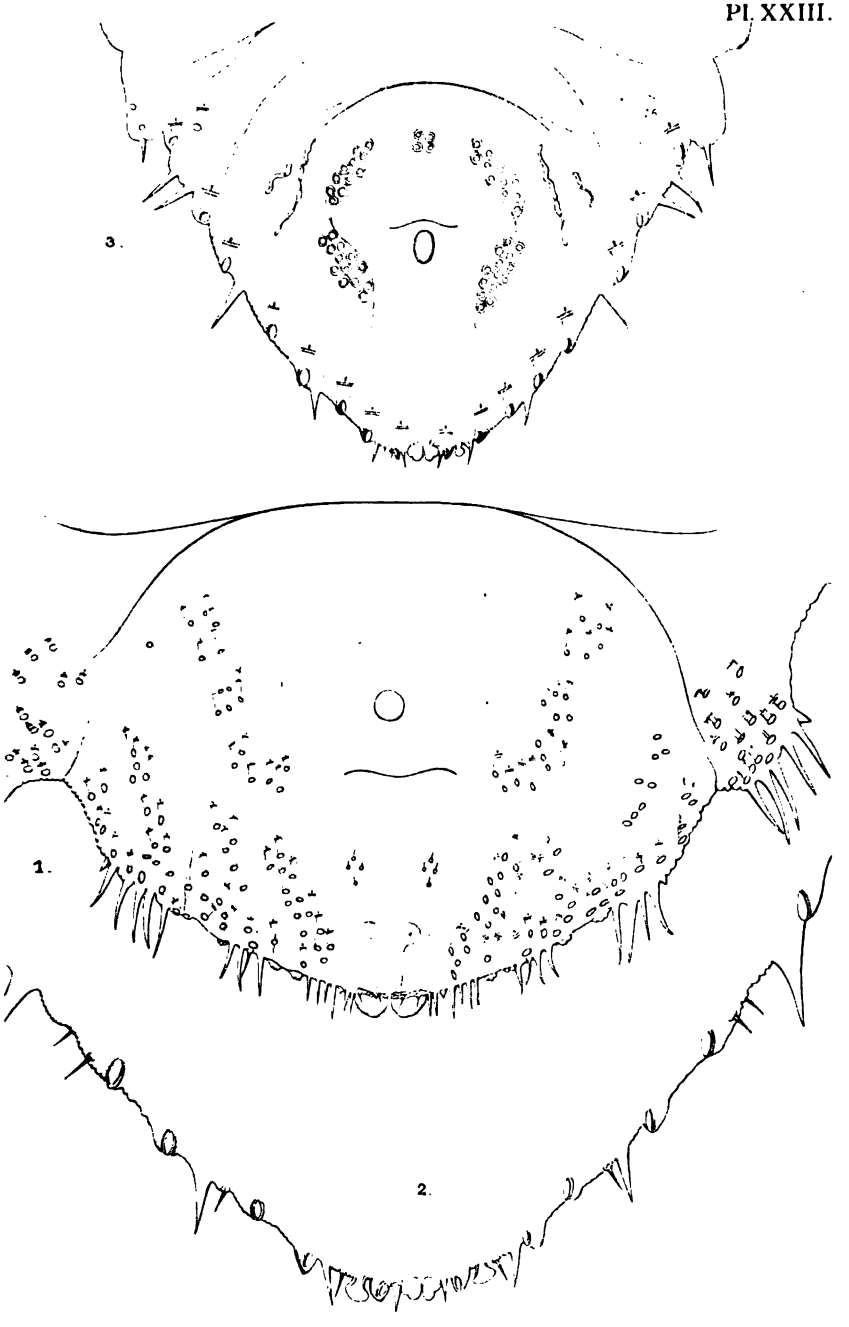

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PLATE XXIV.

EXPLANATION OF PLATE XXIV.

MYTILASPIS POMORUM. (Page 194.)

Figs. 1, 2. Female insects, natural size, *in situ* on branch of apple.

Fig. 3. Puparium of young adult female (dorsal). × 15.

4. Puparia of adult female (ventral) disclosing, in the upper figure, the shrivelled but still living female at the anterior extremity, with the eggs almost filling the puparium beneath her. In the lower figure the larvæ have escaped, leaving the white effete skins behind, and the dead female remaining at the narrow extremity as a dull brownish shrivelled body scarcely visible to the naked eye. × 15.

5. Puparium of female (ventral) disclosing the female at period of gestation. × 20.

6. Puparium of second-stage female at period of fecundation. × 15.

7. Puparium of male. × 15.

8. Male. × 35.

9. Pupa (dorsal). × 40.

10. Pupa (ventral). × 40.

11. Larva, greatly magnified. × 50.

PL. XXIV.

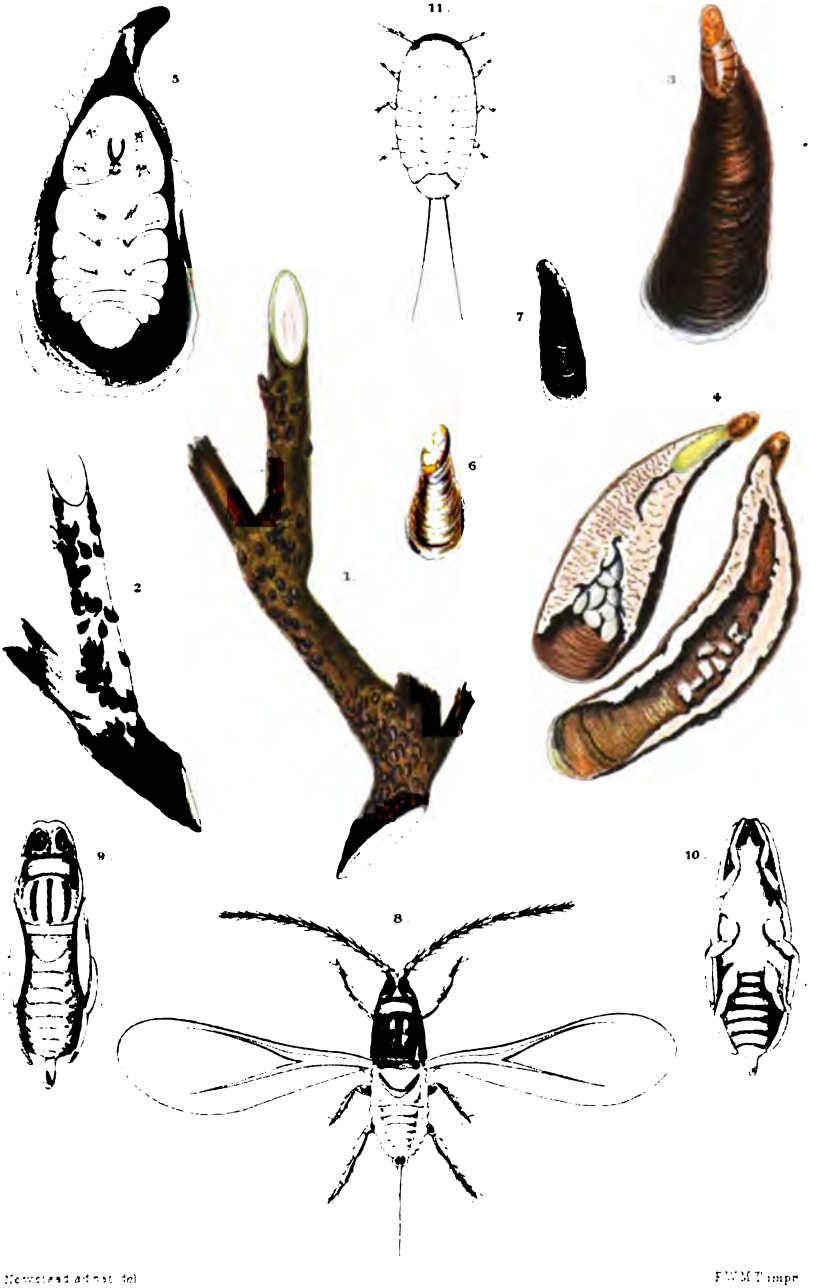

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PLATE XXV.

EXPLANATION OF PLATE XXV.

MYTILASPIS POMORUM. (Page 194.)

Fig. 1. Adult female after treatment with potash (ventral). × 50.
2, 3. Rudimentary antennæ of adult female. × 500.
4. Male antenna. × 100.
5. Terminal joint of male antenna. × 600.
6. Leg of male. × 100.
7. Tarsus and claw of male. × 600.
8. Halter of male. × 600.
9. Spiracle of male. × 600.

MYTILASPIS PINNÆFORMIS. (Page 204.)

Fig. 10. Adult female after treatment with potash. × 50.
11. Cast skin of second-stage female. × 50.
12. Cast skin of larva. × 100.

PINNASPIS BUXI. (Page 207.)

Fig. 13. Antenna of adult female. × 500.
14. Spiracles and parastigmatic glands of adult female. × 500.

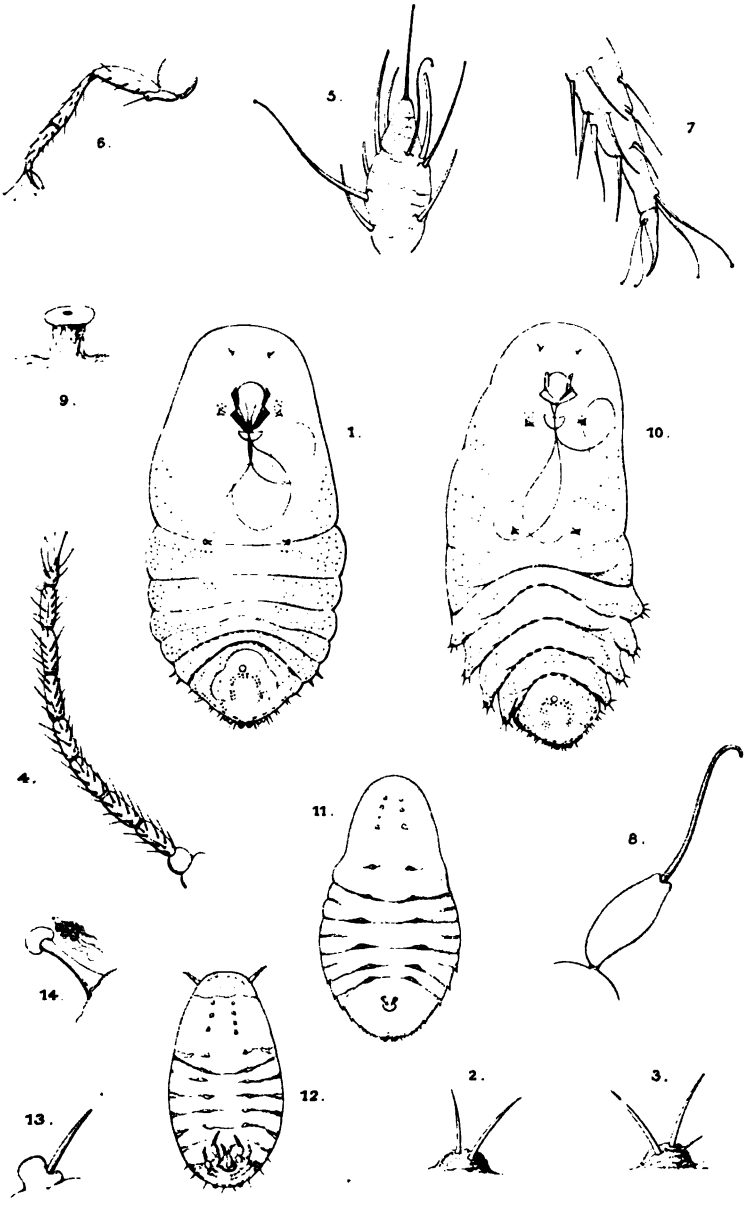

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PLATE XXVI.

EXPLANATION OF PLATE XXVI.

MYTILASPIS PINNÆFORMIS. (Page 204.)

Fig. 1. Pygidium of adult female. × 250.

MYTILASPIS POMORUM. (Page 194.)

Fig. 2. Pygidium of adult female. × 250.

MYTILASPIS FICUS. (Page 202.)

Fig. 3. Pygidium of adult female. × 250.

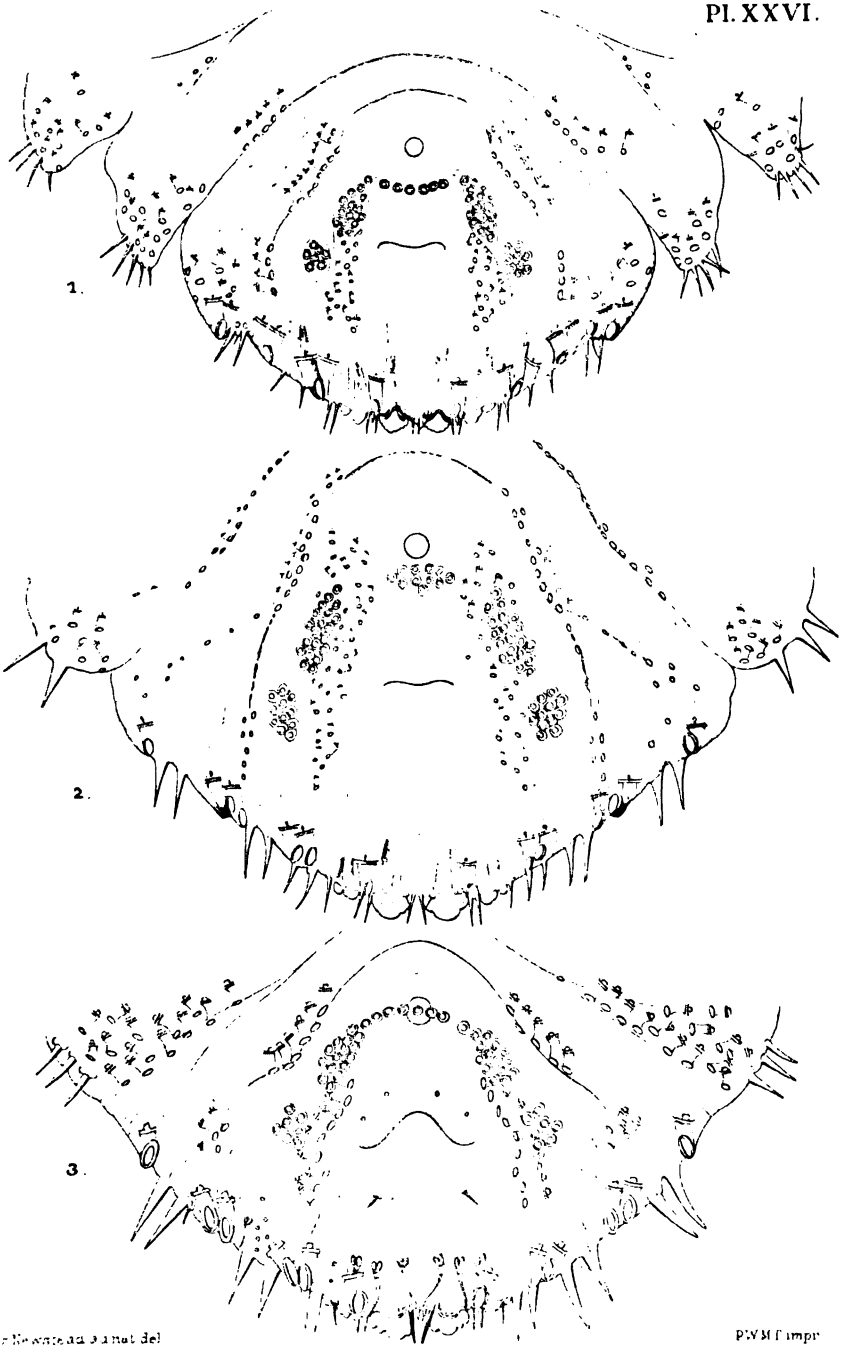
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PLATE XXVII.

EXPLANATION OF PLATE XXVII.

CHIONASPIS BICLAVIS. (Page 190.)

Fig. 1. Margin of pygidium of adult female. × 600.

CHIONASPIS SALICIS. (Page 180.)

Fig. 2. Margin of pygidium of adult female. × 600.

CHIONASPIS ASPIDISTRÆ. (Page 187.)

Fig. 3. Margin of pygidium of adult female. × 600.

MYTILASPIS PINNÆFORMIS. (Page 204.)

Figs. 4 and 6. Margin of pygidium of adult female. × 600.

MYTILASPIS POMORUM. (Page 194.)

Fig. 5. Margin of pygidium of adult female. × 600.

MYTILASPIS FICUS. (Page 202.)

Fig. 7. Margin of pygidium of adult female. × 600.

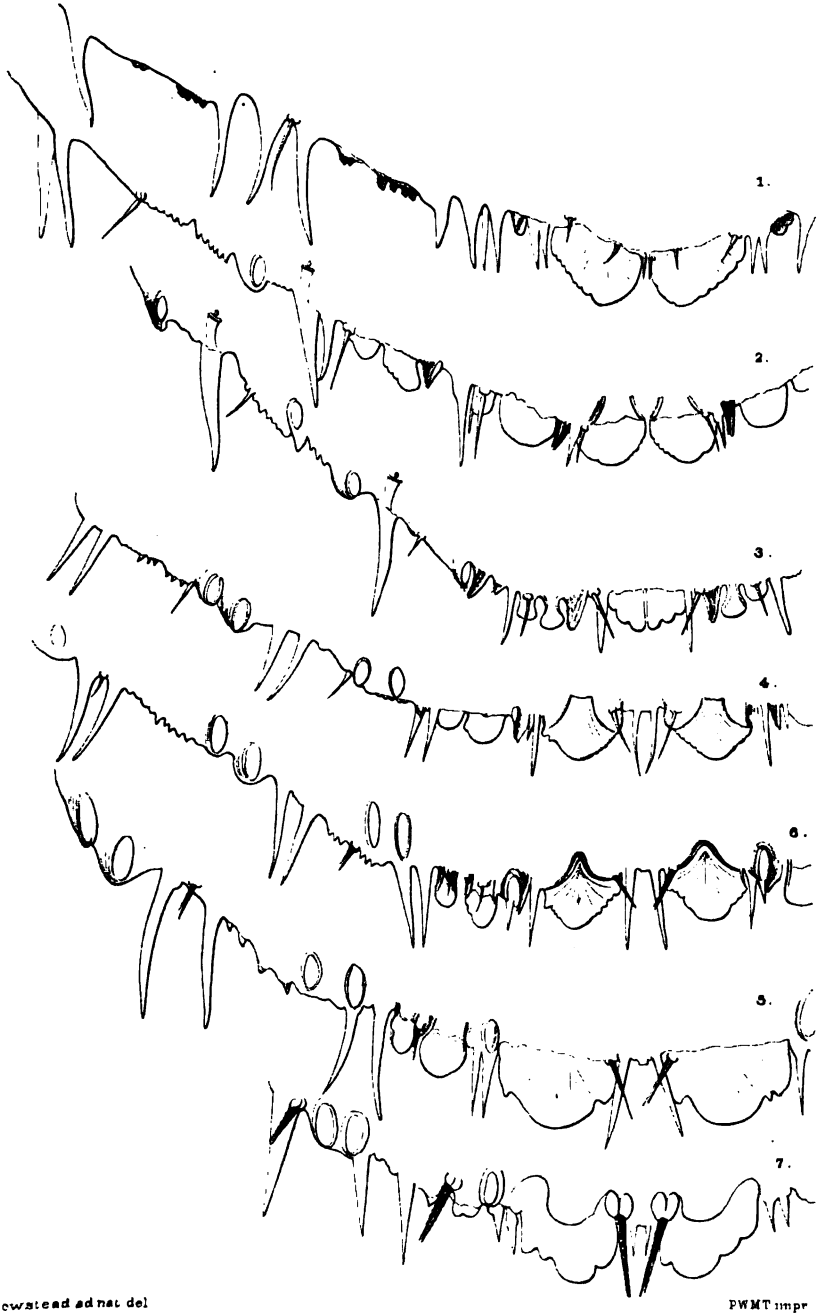

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PLATE XXVIII.

EXPLANATION OF PLATE XXVIII.

ISCHNASPIS FILIFORMIS, Douglas. (Page 210.)

Fig. 1. Insects, natural size, *in situ* on portion of palm leaf.
2. Puparia of adult female (dorsal). × 25.
3. Puparium of adult female (ventral). The dotted lines give approximate position of eggs.
4. Puparium of male. × 25.
5. Adult female. × 50.
6. Adult female after treatment with potash. × 70.
7. Pygidium of adult female (dorsal). × 250.
8. Pygidium of adult female (ventral). × 250.
9. Larval exuviæ covered by secretion which takes the form of tubercles along the margin and on the dorsum. × 100.

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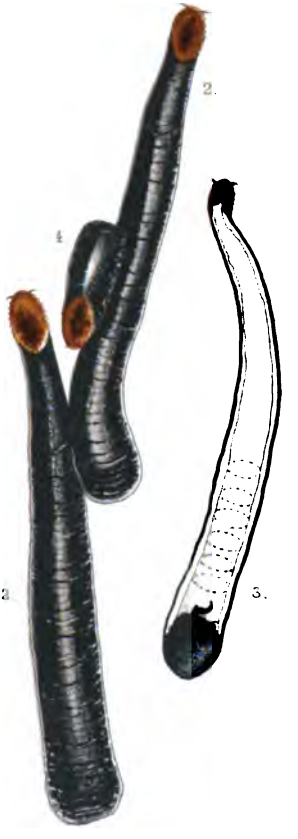
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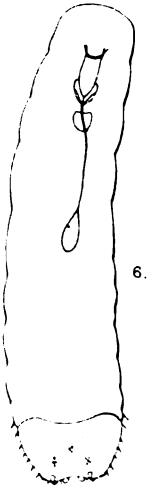
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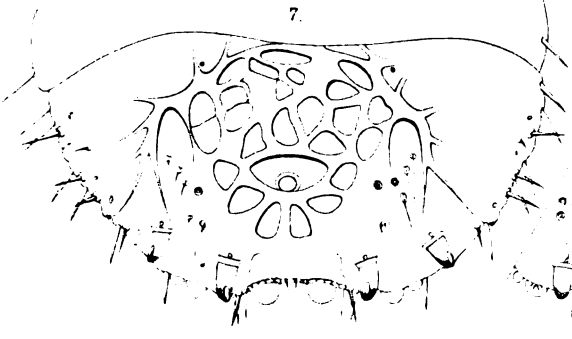
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PLATE XXIX.

EXPLANATION OF PLATE XXIX.

FIORINIA FIORINIÆ. (Page 134.)

Fig. 1. Puparium of adult female (dorsal). × 25.
2. Puparium of adult female (ventral), with part of ventral scale removed, revealing the adult female, eggs, and effete skins, all enclosed within the moulted skin of the second-stage female, the extent of which is indicated by the continuous brown line. × 35.
3. Adult female at gestation. × 35.
4. Rudimentary antenna of adult female. × 600.
5. Spine-like plates of free abdominal segments of adult female. × 600.
6. Pygidium of adult female. × 250.
7. Margin of same. × 600.
8. Second-stage female after treatment with potash. × 40.
9. Antenna of larva. × 600.
10. Seedling palm leaf, natural size, infested by the insects which produce the yellow and brown stains.

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PLATE XXX.

EXPLANATION OF PLATE XXX.

PARLATORIA PERGANDII. (Page 143.)

Fig. 1. Puparium of adult female. × 15.
2. Adult female at period of gestation. × 40.
3. Puparium of male. × 20.

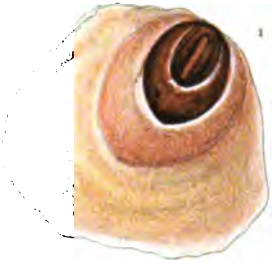
PARLATORIA ZIZYPHI. (Page 148.)

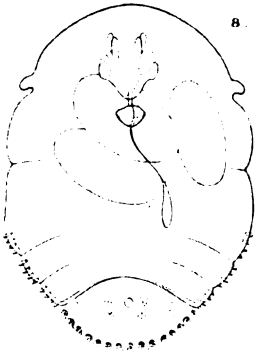
Fig. 4. Puparium of adult female. × 15.
5. Puparium of second-stage female. × 40.
6. Puparium of male. × 20.
7. Insects, natural size, on orange rind.
8. Adult female after treatment with potash, showing outline of ova within the body. × 50.

PARLATORIA PROTEUS. (Page 140.)

Fig. 9. Puparium of adult female. × 15.
10. Puparium of male. × 20.
11. Adult female at period of gestation. × 40.
12. Insects, natural size, on orchid leaf (*Cypripedium*).

PI. XXX.





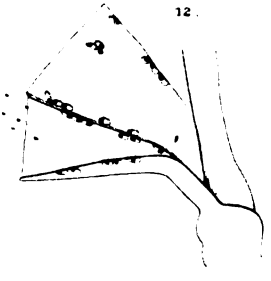


PLATE XXXI.

PLATE XXIX.

PLATE XXXII.

EXPLANATION OF PLATE XXXII.

PARLATORIA PERGANDII. (Page 143.)

Fig. 1. Adult female after treatment with potash. × 50.

2. Fringe of pygidium of adult female. × 600.

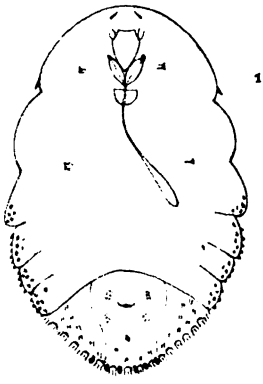
PARLATORIA PROTEUS. (Page 140.)

Fig. 3. Adult female after treatment with potash. × 50.

4. Fringe of pygidium of adult female. × 600.

PARLATORIA ZIZYPHI. (Page 148.)

Fig. 5. Fringe of pygidium of adult female. × 600.



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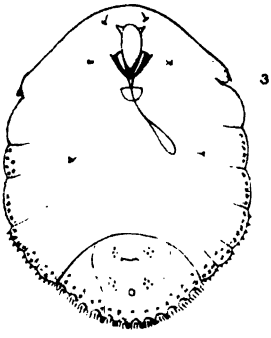

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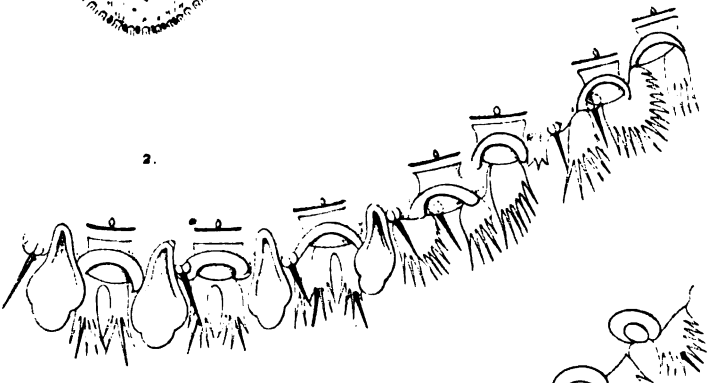

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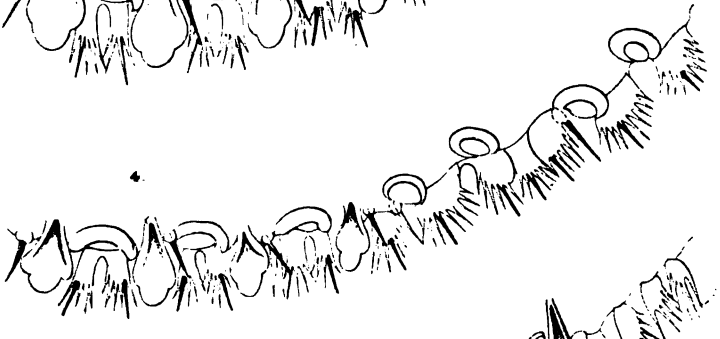

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PLATE XXXIII.

EXPLANATION OF PLATE XXXIII.

PARLATORIA PERGANDII. (Page 143.)

Fig. 1. Pygidium of adult female. × 250.

PARLATORIA PROTEUS. (Page 140.)

Fig. 2. Pygidium of adult female. × 250.

PARLATORIA ZIZYPHI. (Page 148.)

Fig. 3. Pygidium of adult female. × 250.

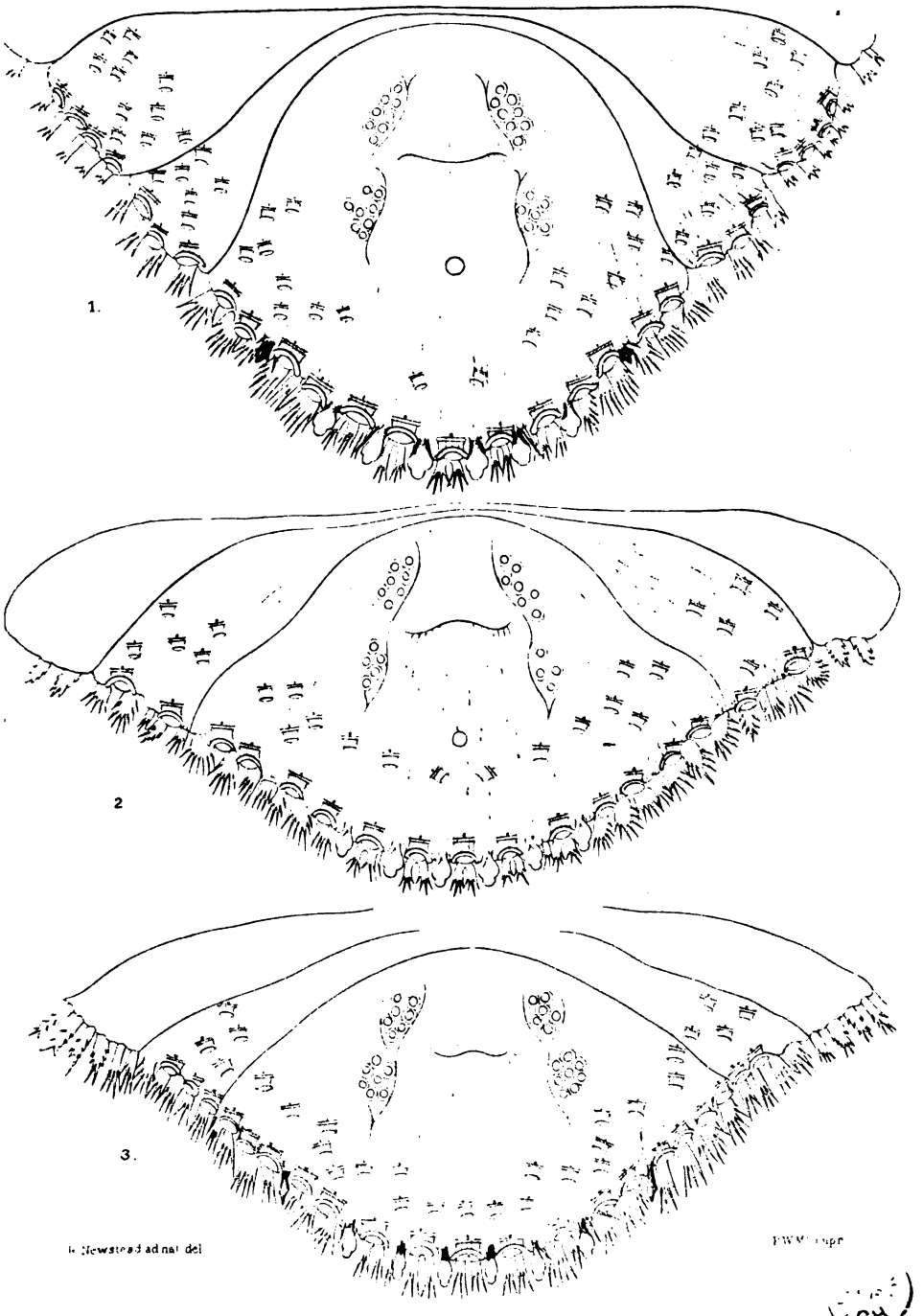

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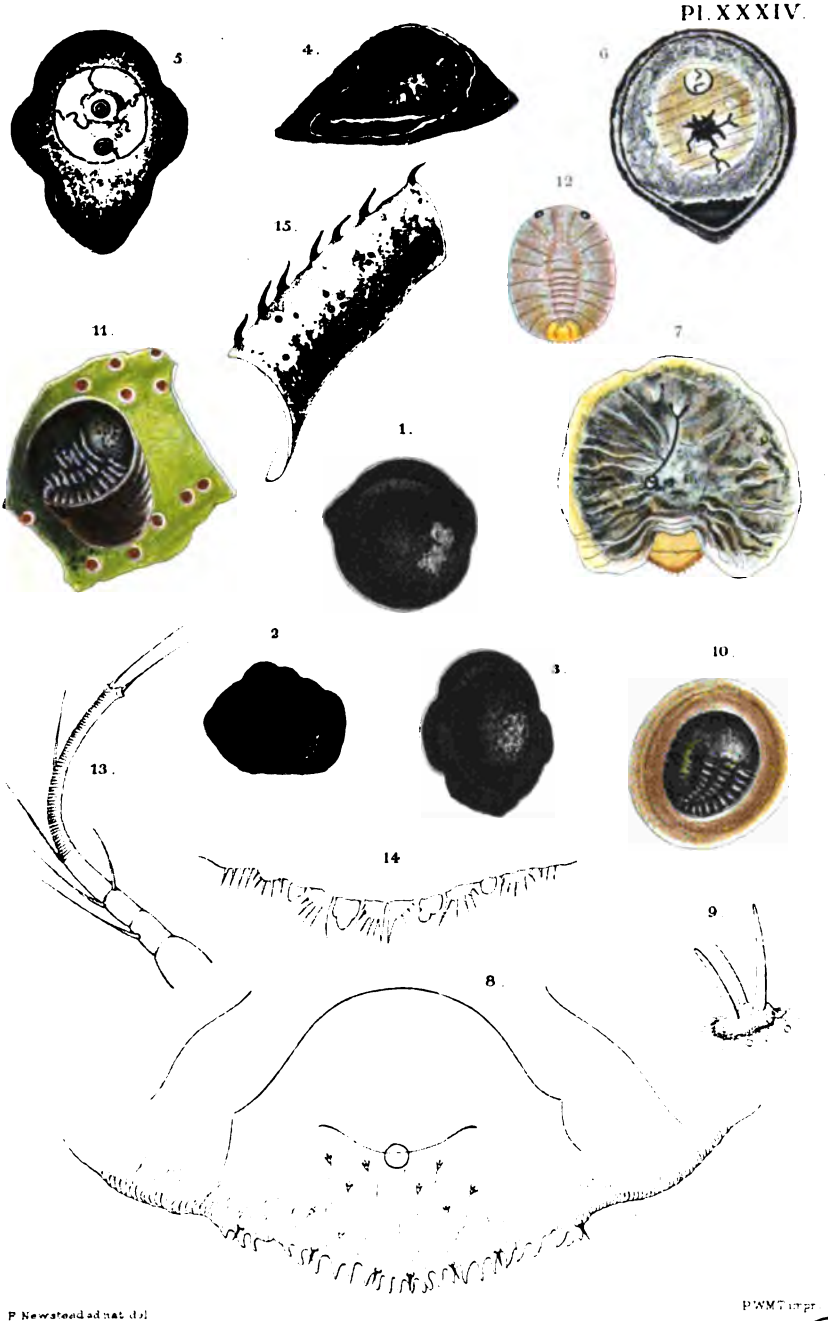
PLATE XXXIV.

EXPLANATION OF PLATE XXXIV.

GYMNASPIS ÆCHMEÆ. (Page 131.)

Figs. 1—3. Puparia of adult female (dorsal). × 25.
Fig. 4. Puparium of adult female (profile) with portion (skin of second-stage female) removed, disclosing the adult female within. × 35.
Figs. 5, 6. Ventral view of female puparia showing impressions of leaf structure on the thin white ventral scale. × 35.
Fig. 7. Adult female (ventral) at period of parturition. × 60.
8. Pygidium of adult female. × 500.
9. Rudimentary antenna of adult female. × 600.
10. Puparium of second-stage female which is cast off before the insect makes its final moult. × 50.
11. Puparium of male. × 50.
12. Newly hatched larva. × 80.
13. Antenna of larva. × 600.
14. Pygidium of larva (margin). × 600.
15. Insects, natural size, *in situ* on portion of leaf of *Æchmea aquilega*.

PI. XXXIV.



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